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RADIO

ESTABLISHED 1917

SHORT-WAVE AND EXPERIMENTAL

—IN THIS ISSUE—

The "Gainer"—A Two-Tube Receiver
The Banehawk Superheterodyne
Practical Grid Modulation
More Power Output—by W6CUH

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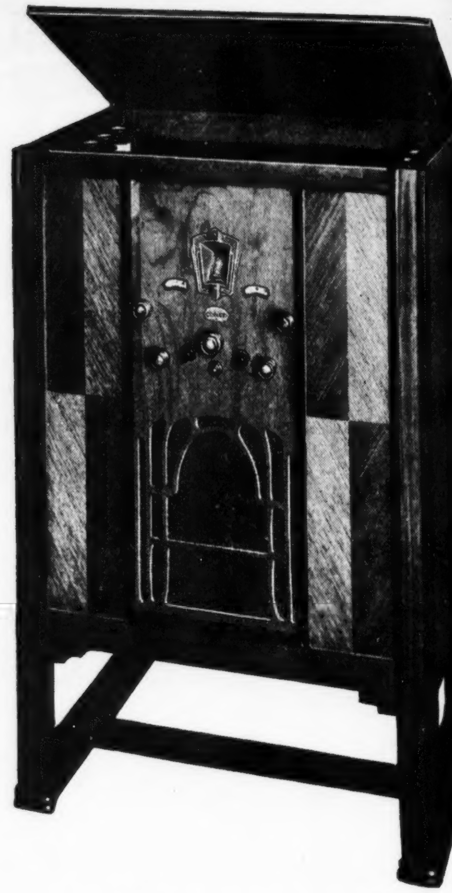

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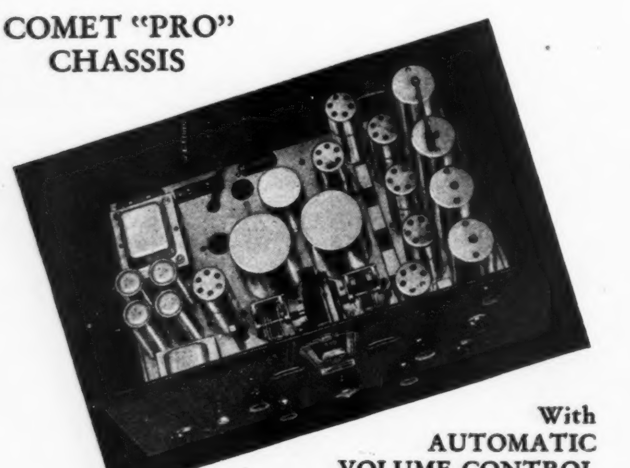

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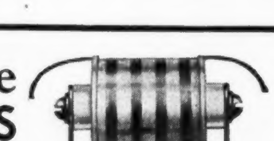

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Vol. 16 FEBRUARY, 1934 No. 2

RADIOTORIAL COMMENT

SOMEONE slipped a joker into the Madrid treaty. Nor is it the sort of joker that you find in a pack of cards. It is a political joker: a clause that is ambiguous or apparently immaterial, inserted in a law so as to accomplish a nefarious purpose without arousing opposition at the time of passage. Someone counted on Little Boy Blue's being under the haycock fast asleep. He was. Someone had pulled the wool over his eyes. When called to do his duty, he denied that he had been asleep and refused to blow his horn. And the old watch dog was off chasing rabbits because he had been told that he was not wanted.

Something had to be done pronto if that joker was to be killed. The old watch dog could bark. So he was called to warn of the danger that threatened. Obedient to the call, he did his best. But it's a big job and he needs Little Boy Blue's help. Meanwhile Little Boy Blue is trying to hamstring the dog, be-littling and be-damning his efforts. Instead of trying to kill the joker, Little Boy Blue is blithely singing "Who's Afraid of the Big Bad Wolf?" Perhaps the watch dog will succeed, notwithstanding Little Boy Blue's pacifist opposition to defensive warfare against invasion of amateur priviliges.

Anyhow "RADIO" has been called back on the job again and is glad to assume aggressive leadership. There's lots of real work to be done in helping to get more and wider bands for amateur use. With the likelihood of a governmentally-enforced merger of the commercials, according to press reports, there's a good chance for the eventual recovery of some of the grabbed channels. You can count on our doing our darndest, with your support.

That support has already been much greater than was originally anticipated. The West is, of course, pulling for "RADIO". But, "believe it or not", the Pacific Coast states absorb only 5 per cent of the circulation, the other 95 per cent going to the East and to foreign countries. For this please accept our sincere thanks. We will continue to try to merit your confidence. It doesn't matter where a magazine is published; it's where it's read that counts. And a lot of good things besides young Lochinvar have come out of the West.

Seven months ago, five copies of this magazine went to Honolulu; now, 300 are bought there every month. The technical editor of "Radio News of Australia" advises his readers to "subscribe for 'RADIO', the foremost American radio magazine", as he puts it. Is our face red because some good friend pats us on the back? No, it merely makes us dig deeper for new and better ideas to help make amateur radio worthwhile. We're seventeen years old this year, having been published continuously since 1917, except while the "staff", with a ham experience dating back to 1907, were serving Uncle Sam during the World War.

"RADIO" was boosting the amateur game even after being told that it was not wanted. It has always befriended and never betrayed the amateur. Now that it has come back to the fold, it would like to be friends with Little Boy Blue and Little Bo Peep, rather than being forced to fight with them. For when "a feller needs a friend", the friend also needs a feller.

●●●

A FOREIGN correspondent wants to know whether "RADIO" has only one string to its radiotorial harp. He objects to the policy of always harping about the unfair treatment to which the radio amateur has been subjected in America and infers that there are other subjects which would be more interesting to amateurs who live elsewhere. Such criticism is welcome, especially when it is accompanied by constructive ideas, which this destructive critic fails to enclose. These columns seek to mirror as well as to mold public opinion.

Let it be known, however, that this radiotorial harp has its full complement of strings, as this page may reveal, but that it will still be necessary to harp on that one string until the evils have been corrected. As Will Shakespeare once remarked, "Harp not on that string, madam; that is past", so will we cease to dwell on the shabby treatment of the American amateur only when he receives his just due. And it may be added that it requires a good harpist to provide acceptable music with one string.

●●●

SWITCHING the metaphor to meet the needs of the Anzacs and other internationals whom radio has made next-door neighbors, let us restring our bow to speed an arrow into space. If our aim is as true as it is well-intentioned, the arrow will hit the bull's-eye, in spite of what the poet has sung. How about coining an International Radio Language?

The thought is inspired by recent efforts to promulgate the use of a list of 200 English words which meet all the needs of polite conversation between any two peoples who do not understand each other's lingo. English words are proposed, rather than Sanskrit, Chinese, or what-have-you, because the great majority of literate persons can read them, even if they don't speak them—correctly. While it is admitted that such a language does not possess the beauty nor the flexibility of Esperanto, for example, the fact remains that after all these years of propaganda few persons are fluent in Esperanto as compared to the number who are articulate in English. Music and mathematics are also universal languages, but too few people understand them well enough to permit their general acceptance as vehicles for expressing thought.

There is another universal language which is more-widely understood than even English. This is the language of the "Q" signals. It is really remarkable how many ideas can be expressed by means of this very short list of abbreviations and a few additional terms well known to radio amateurs. That these are beyond the comprehension of the non-radio public is perhaps an advantage. In the lack of a more complete vocabulary the following is quite suggestive:

Suppose that your QRA? brings you a QSY from Mae West which you interpret as her much-quoted invitation. You QRL? She QRL. You QRX. She QRX, and later QRU? You QSJ?, and as her QSJ is satisfactory, you both 88. You QRV? She QRV, K. (Rest of message deleted by censor). 13?

But seriously speaking, the idea is worth considering. A list of about a hundred abbreviations could easily be compiled so as to cover 99 per cent of all normal third-party communications. When translated into a dozen or more different languages it would serve a world-wide need. What think you?

●●●

"KEEPING up with the Jones'" is child's play as compared to keeping up with the new types of radio tubes. Heinz' 57 varieties are completely outclassed by the 77 types of tubes that one manufacturer was marketing last November, and nobody knows how many more since then. Nor does this include the special types which are being sold by the other manufacturers. The number has nearly trebled during the last three years.

Usually there has been no more rhyme nor reason in naming a tube than in christening a new Pullman car. Recently, however, there has been a semblance of an attempt to introduce some sort of order into this chaos, by adopting a new numbering system. Thus, for the 2A3 tube, as an example, the first number indicates the heater or filament voltage, the middle letter gives the tube designation, and the final digit specifies the number of usable elements with external connections. Here is a clue, at least, to help the detective solve the mystery, to guide a victim through the mystic maze.

Why not scrap all the old designations and make a new start by giving new names to all the tubes, as they did to the survivors of the Russian revolution? It would be less difficult to remember a complete list of new numbers which mean something than to continue to guess about a lot of nonsensical numbers which mean nothing. Or do the radio correspondence schools also sell a memory course?

COL. FOSTER'S COMMENT

W6HM

"BLIND TRAFFIC"

A Thrilling Account of Amateur Radio Courage

As one of the many fine performances of amateur radio in 1933 we commend the trans-pacific work of KA1LG and W6CXK.

LEON GROVE (KA1LG) is Superintendent of Schools in the Philippines with some 800 teachers to direct and supervise. Many of these teachers, as well as other employees of the Philippines Bureau of Education, are Americans. They need communications facilities, but they have no money to pay for the services of the commercial communications corporations. So Grove's list of "customers" is a long one. We asked him for some items of interest for publication in RADIO.

"Well," *he responded,* "*my most interesting experience was sending my traffic 'blind' to Emile Guidici, W6CXK. There is material for a good story in it, but you will have to ask Emile for the details at his end. All I know of his side is what I learned over the air.*"

"*On Sept. 1st he told me he had a job that would take him high up in the Sierras for five days a week, and that he would be home for schedules on Saturdays and Sundays. He was taking his portable receiver along, but there was no power for a transmitter up there in the big timber. He suggested that I send blind to him on Tuesdays and Thursdays. This worked well. When he came home on Saturdays I gave him what fills he needed. In the two months he was up there I sent him, blind, 200 messages originating in PI and China. Although I sent them all single, he required only a few fills in 30 messages. That percentage of reception would be good under the best of home conditions; under the unusual circumstances I consider the work of W6CXK truly remarkable. During one month of his stay in the wilds he hadn't even a tent. He told me that he had to lay in bed to receive; I presume on some kind of army cot. When he came home from camp for his first week-end his blankets were white with frost and he had to wrap his hands so he could hold a pencil. During the latter part of his stay he obtained a tent, but the cold was extreme and there were heavy snows.*"

"*One week-end he failed to show up at home. I called him the following Tuesday, sent him a few messages blind, and told him I hoped he wasn't ill or buried in the snow. I learned later that there had been a bad snowstorm in the mountains and that he had been unable to go home.*

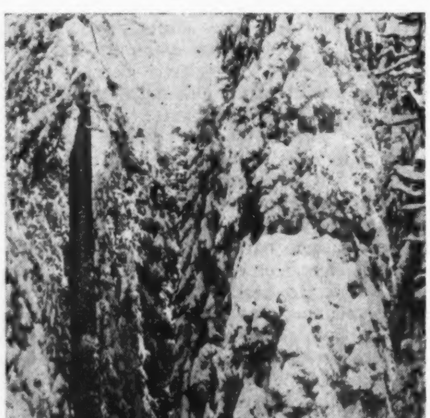
"*Now, for work under difficulties, and for fidelity to the true spirit of amateur radio, I submit the work of W6CXK as an outstanding instance. Ever since you went off for your holidays he has been most faithful to schedules and he has certainly pounded out the traffic. He puts a good consistent signal into the Philippines, and when it comes to copying he is second to none. Some days, through long strings of messages, he would come back with almost monotonous regularity, 'R,K,'—received, go ahead.*

"*You surely hooked me up with a real guy when you introduced me to a fellow-member of our Trans-Pacific Traffic Association, Emile Guidici, W6CXK.*

Signed, "*LEON C. GROVE, KA1LG.*"

NOW listen to W6CXK's side of the story.

"Aw, without KA1LG's consistent signals and Leon's fine, steady fist I would have got just nowhere in trying to keep blind skeds.



W6CXK "Bails Out" of the Snow!

"About Sept. 1st I learned that the Forestry Service was sending me 14 miles higher up in the mountains. I found that I could get down home Saturdays and Sundays to keep skeds. That wasn't going to keep Leon's hook clear, so we arranged that he send blind to me on Tuesdays and Thursdays at my 5.00 AM—his 9.00 PM. Boy, she sure was cold and dark up there at 5:00 o'clock.

"My first day in camp I guess I did more work for the Bureau of Education of the Philippines than I did for our Uncle Sam. There were tall sugar pines around a small meadow where we made our camp. There were some giant Sequoias, too, but you know a feller can't shin up a tree that is 30 feet in diameter. But I got up the sugar pines and stretched an antenna clear across the meadow. My receiver was a simple regenerative affair, detector and one audio, built into a tin fishing tackle box, batteries and all. Not much room for batteries, so the signals weren't exactly deafening.

"For the first month I had no tent; just slept on a cot under a pine tree. The foot-long cones of the sugar pine can knock a feller's brains out. On the bare assumption that I might have some, I kept the head of the cot close to the tree trunk. That was a swell layout! I didn't need to count sheep to fall asleep. The soughing of the breezes through the pine needles was soothing. Seen through the trees the stars swung lazily as they do from a ship in a quiet sea. Only the howling of the coyotes broke the stillness, but I'm so used to it that it forms merely a part of the noise-level.

But even before the real winter came it grew very cold with the setting sun and by morning my blankets were white with frost. I had to take care to put my clothes under the blankets. The first morning after I had neglected to do so, I found them frozen stiff. Just try putting on a shirt in that condition! And KA1LG telling me the mosquitoes were biting him through streams of perspiration! If only we could have split the difference!

"I got a great thrill the morning of the first grand trial of the blind skeds. Just before 5:00 o'clock I reached out in the freezing air, turned on the receiver and put the icy fones on my dome. (Thereafter, you bet, the fones, too, slept under the blankets with me.) I got pencil and paper ready, then pulled myself back down into the sleeping bag like a turtle backing into its shell. I waited thus for five o'clock to come. I was lying on my stomach with the fones on, pad and pencil in my hand—all of us down under the blankets—and all set for Leon. I reached out and tuned the receiver back and forth across his end of the forty band. My watch must have been fast, for no KA1LG; and you know what an accurate sked-keeper Leon is. When my hand was nearly frozen, I was about ready to quit. Then I thought I heard the old, familiar note. Shivering with cold and excitement, I adjusted the regeneration to peak sensitivity and tuned again. Shades of DX, there was KA1LG calling W6CXK! That was a greater thrill than I got from hearing my first South African.

"Leon called for a long while before he

(Continued on page 34)

The Banehawk Superhetrodyne

By CLAYTON F. BANE and NORRIS HAWKINS

PART II

LAST month we discussed a means of getting the signal from the antenna to the receiver proper, with a minimum of noise or loss of signal strength. We will now proceed from this point to the high-frequency portion of the receiver.

It is basic that the first point of consideration in any receiver is SENSITIVITY. This is no less true in a super-het than in the more simple receivers, it being a well-established axiom that you cannot amplify that which does not get to the amplifier grids. Sensitivity, however, must be accompanied by the minimum of noise in order to provide the utmost in readability, an absolute necessity in a communication receiver. The question often arises as to whether or not a super can have as good a signal-to-noise ratio as a simple, screen-grid regenerative detector. The answer is **yes!** A properly designed super can have **greater sensitivity because its high** degree of selectivity effects a reduction in the interference due to atmospheric noise. This atmospheric noise is present in the output of any receiver and is a function of the width of the admittance band. In other words, most static appears simultaneously over a wide frequency band, so that it follows that the narrower the band of frequencies admitted by the receiver, the lower the noise level.

There can be no doubt but that a superheterodyne receiver is materially more selective than any practical form of TRF receiver, but we must be sure that the super does not possess so much inherent tube and resistor noise because this noise will more than offset the reduction in atmospheric noise. This is a too-common trouble of many of the conventional high-frequency superheterodynes now being used in amateur stations. We believe that our version of the superheterodyne represents the ultimate in this respect. By eliminating all noise except that which is caused by the tubes we have only the tube noise to contend with. The answer to this problem lies with the tube manufacturers.

Having favorable signal-to-noise ratio at the input terminals of the receiver, it is highly desirable to maintain this ratio constant throughout all the stages. To do this successfully, every circuit in the receiver that produces noise must also produce an equivalent amount of gain, so that the **RATIO** of noise-to-signal is not adversely affected. This brings us to a consideration of the advantages and disadvantages of a stage of tuned radio frequency ahead of the first detector.

It is well known that the gain of a radio frequency amplifier falls off as the frequency is increased, until at about 4 meters it becomes impossible to realize any gain at all with the conventional receiving pentodes. A gain of 25 is considered high at 7000 KC in conventional amplifier circuits. Measurements of noise show that such an amplifier produces practically as much noise as it does signal gain, so that the signal-to-noise ratio is not improved. This being so, it seems like a needless complication to add a radio frequency stage for the sole purpose of reducing image interference. With many high frequency receivers showing gains of only 10 to 15 for this stage, it would seem that such stages might better be left out. One of the more successful receiver manufacturers frankly admits this drawback and uses, in its stead, a two section band-pass filter before the first detector. This manufacturer might just as well have used the extra tuned circuit for a RF stage and the extra tube and socket would have added only slightly to the cost. It was found, however, that the weak signal response was reduced by adding the extra tube. Practically all receiver engineers agree that inability to realize sufficient gain is the chief deterrent to the use of a TRF stage. Complete or partial image suppression practically demands the use of some kind of a pre-selector stage, with or without RF gain.

Coupling the antenna into the RF stage has the effect of increasing its resistance or, to state it another way, flattens its resonance curve. This reduced "Q" reduces both selectivity and sensitivity. Identically the same thing occurs in the simple regenerative detector, as is attested by the extreme lack of selectivity when these detectors go out of regeneration. Introducing a negative resistance by means of feedback has the property of cancelling some of the increased circuit resistance and in this way greatly **increases the selectivity.**

The Banehawk receiver uses a REGENERATIVE stage of tuned RF ahead of the first detector to increase its gain and selectivity. We claim no originality for this idea; it has been used or tried by a great many persons. All have discarded it. Then why do we use it? Because an entirely new mechanical arrangement of parts and shielding eliminates the instability and interlocking hitherto encountered. An isolation seldom realized has been accomplished by forgetting, entirely, existing mechanical arrangement and throwing convention to the four winds.

The practice of running the plate RF lead to the detector grid circuit over most of the wiring of the set, and thus losing half the signal to ground, has been abandoned. Both the detector and RF tubes are mounted in a horizontal position. In this way both the grid and plate leads are made exceptionally short and direct. One inch each, to be exact, and this includes the usually-long RF-to-detector lead. The use of exceptionally short leads between stages tremendously increases the sensitivity of the receiver by avoiding losses, in addition to keeping the RF regeneration where it belongs—in the screen circuit of the RF stage.

The question arises as to the advisability of making both the detector and RF stage regenerative. Regenerative detectors have a disadvantage; rarely does optimum regeneration and detection call for the same circuit conditions, while regeneration and amplification go hand in hand. Perhaps the word "Detect" is inadvisable when used in reference to supers, but this term is most generally used to identify the "Mixing" stage and thus we prefer to use it in this series of articles.

A detector must, above all, detect efficiently. By making it regenerative we are usually forced to sacrifice detection efficiency. There is an additional reason for not making the detector regenerative. Tests show that the first detector is a prolific source of noise (how much of this is due to the oscillator is impossible to determine because the oscillator and first detector must function together). If we make this first detector regenerative, we also regenerate the unwanted noise. It has been shown that the resonance curve of a detector using regeneration is broad at the base, although markedly and suddenly narrow toward the peak. The width of the curve at its base largely dictates the noise admittance width, so that it can be seen that regeneration, though possibly providing more gain, in no way increases the signal-to-noise ratio. "Pulling", or interaction, from the oscillator is another likely consequence of the use of regeneration in the mixer stage.

The bottom section of the rack shows the high-frequency unit of the Banehawk Receiver

Power detection has so many advantages that it was incorporated into our receiver without a second thought. However, the usual method of obtaining bias, i.e., cathode resistor, was abandoned because the bias is greatly affected by various changes in signal and oscillator voltages. To our way of thinking, batteries have no place in an AC operated receiver, so the bias for the detector was obtained by means of a variable resistor from the ground-end of the B strip. This resistance is variable, allowing a very exact adjustment of the bias voltage, and consequent operation of the detector on the correct position of its characteristic curve for maximum signal to the IF stages.

RF and detector stages are tuned by means of a ganged condenser, while the oscillator has a separate control. This two-dial control is really very helpful in communication work, because of the ability to beat stations through by deliberate mis-alignment of the oscillator-detector circuits. Successful three-gang receivers are so complicated, in order to avoid interlocking and correct ganging, that their use is really beyond the scope of the average amateur mechanic. We prefer to stay with convention in this one respect and retain the two dials.

Band-spread is provided for the oscillator by using a variable system that allows any degree of band coverage desired.

The oscillator is a modification of the electron-coupled circuit. It is somewhat unusual inasmuch as it operates at half the frequency to which the detector-RF stages are tuned. In other words, the second harmonic of the oscillator is utilized. This helps materially in stabilizing the oscillator, especially on 14 and 28 MC. Any tendencies to interlock are greatly lessened and, in addition, the oscillator

(Continued on page 23)

Increasing Power Output

By CHAS. PERRINE, Jr.
---- W6CUH ----

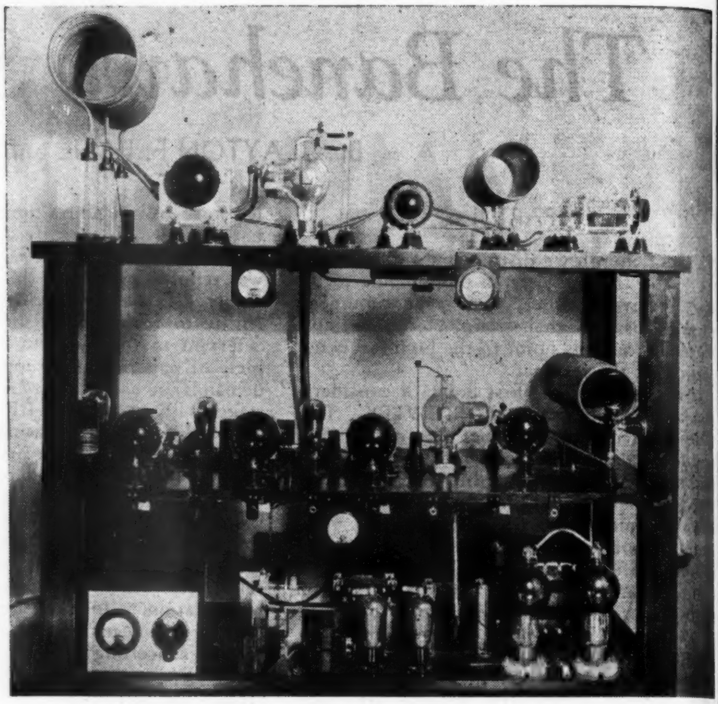
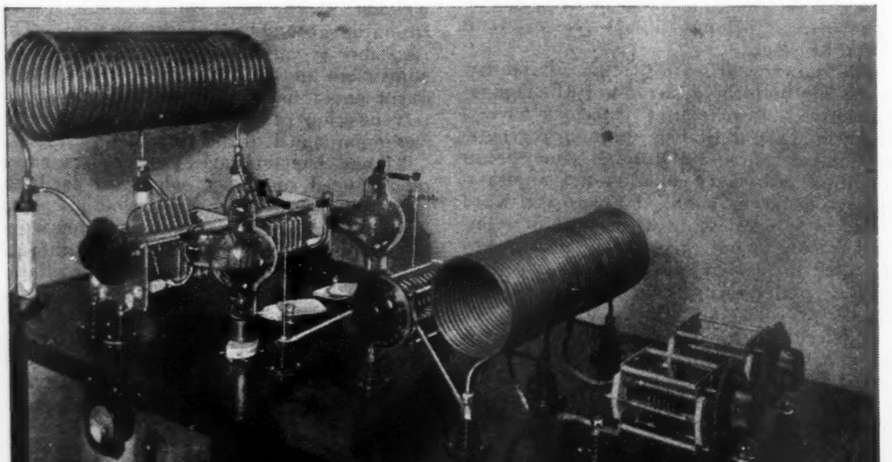


FIG. 1—A Radical Departure in Transmitter Design

THE attainment of high efficiency in the output amplifiers of crystal controlled transmitters has intrigued many amateurs, but the difficulties and pitfalls accompanying this quest have discouraged many an ambitious ham. The forerunner to this article, "Thirty-Three Watts Per Dollar from a Type '52", attempted to present and apply the considerations necessary to high efficiency. Since that article was written, we have had a chance to watch these principles in action under widely different conditions, to work out further improvements, and lastly to determine the absolute as well as the relative importance of the factors concerned. This material will be presented from a strictly practical viewpoint, even to the theory necessary to explain certain contentions; in addition, numerous examples will be cited, including a complete description of a 1KW type '52 transmitter.

A very brief review of the original article will not be out of place. It stressed the necessity of using a high plate voltage on the tubes, high excitation, and a high LC ratio in the output tank circuit. The major portion of the article contained practical dope on the application of these principles to a transmitter using a single type '52 buffer feeding an output amplifier with two type '52's in push-pull. The tuning procedure was treated in great detail, and the reader will do well to refer back to it as it applies equally well to this article—the precautions taken should be noted with great care.

The use of Low-C and the advisability of mismatching the tank and tube plate impedances in order to gain efficiency have already been well covered in "RADIO" by W6WB, but there is one point that has been overlooked. The argument that greater efficiency results from the use of Low-C and a consequent high load impedance ($Z = \frac{L}{CR}$) is usually met with the statement that matching the load to the plate impedance results in greater output, which after all is what we are really after. This statement is based on the assumption that a tube produces a constant RF voltage as in the case of a battery where matching impedance of battery and load gives maximum output. This assumption of constant RF voltage is erroneous, for a tube will produce higher voltage with higher load impedance, an effect which may be increased by the use of high grid excitation voltage. Thus we see that high excitation voltage is necessary if we are to obtain both high efficiency and output—and this is where inductive coupling comes into play.



Low-C Personified. A beautiful arrangement for a Push-Pull Final Amplifier

Inductive Coupling

INDUCTIVE coupling between amplifier stages has been regarded too often as a nice adornment rather than a necessity for correct excitation. It has already been shown that a large grid voltage swing is desirable. Inductive coupling produces more excitation voltage with a given buffer input than either capacity or direct coupling. In the first place, a much lower C grid tank can be used because we have removed the buffer tube capacity, and in the second place greater buffer efficiency can be obtained because the buffer plate tank may be made lower C. Another factor that enters the picture at high frequencies is the broadening in the tuning of the buffer tank caused by the effective resistance introduced into it when both the grid and grid RF choke losses are so closely coupled to the tank as is the case in capacity coupling. The same applies in part to the many forms of direct coupling. The moral of all this is not to blame the erratic behavior of one's buffer on poor neutralization or on the preceding doubler but to take a look at the coupling between the buffer and the following stage.

Inductive coupling really comes into its own with push-pull because it is the only system that will provide truly balanced excitation. The pick-up coil and feed line are used in addition to the tuned grid tank because they allow much greater flexibility. The coupling may be adjusted without a serious effect on

tank tuning. Furthermore, with high power the grid and buffer tank coils are so large, as we will see later, that it would be a difficult mechanical feat to place them in adjustable inductive relation. There is simply no comparison between this improved inductive coupling and the other types of coupling—direct experiment proved that. And before we leave inductive coupling it might be well to mention the fallacious belief held by many that the grid tank or coil need not be tuned. This mistake may be due to the fact that some use the so-called "untuned" grid coupling coils consisting of many turns of relatively small wire—the fact is that these coils either resonate with the buffer tank because their natural period does so or because they are forced into resonance by shock excitation due to close coupling.

Some Difficulties Which Were Encountered

BEFORE we go on to new material, it will be worth while to cite a few examples of the improvement brought about by application of some of the above principles. The transmitters at W6USA furnished a fertile field for experiment while in course of development. The 7 MC type '04A output tube stopped heating when its plate voltage was increased from 2500 to 3500 volts, the original plate tank was replaced by a duplicate of that at W6CUH, and the input to the buffer Type '03A was increased from 150 to 300 watts. The high excitation brought trouble because the resulting high grid current on the Type '04A ruined "C" batteries in a few days—and that is where resistor bias saved the day; it was substituted for the battery bias without affecting the operation of the set in any way. Incidentally, primary keying cured key clicks hat were audible within a radius of several miles. Another transmitter worth mentioning is that at W6BVC employing a Type '60 to excite a Type '61—it originally employed rather Hi-C with center tap keying at 3500 volts; operation was erratic, the '61 heated somewhat, and terrific keying surges broke down plenty of insulation. Suffice to say that a Low-C output tank brought the plate down to normal, primary keying cured all surges and clicks besides producing a really pretty crystal signal, and, lastly, resistor bias eliminated a messy 450 volt pile of "C" batteries. Now, just one more case at the other end of the scale—a single Type '10 pushing a pair of Type '10s in push-pull, crystal controlled, at W6DLN—the output stage can speak for itself with 250 watts input. All of which goes to show that much can be done along these lines to improve any crystal controlled transmitter.

Theory Is Practice

ALL this talk about theory and just what is to be done in order to gain high efficiency really demanded some concrete backing, such as a few actual determinations of efficiency. One of the best methods of determining efficiency at high frequencies is by measurement of the plate dissipation in the tube itself. To accomplish this, a simple thermo-couple, consisting of an iron and a constantan alloy wire welded together, was attached to the glass envelope of each of the Type '52's in the output amplifier at W6CUH. An 0-1 milliammeter served to indicate the current generated by the two-thermo-couples in series. The whole affair was then calibrated by applying known plate inputs to the tubes with the grids open. Thus there resulted an actual "plate dissipation" meter. The absolute accuracy of measurement to be expected is within 5%, but the relative accuracy of readings is within 1%.

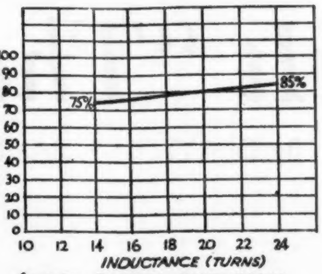


FIG. 2

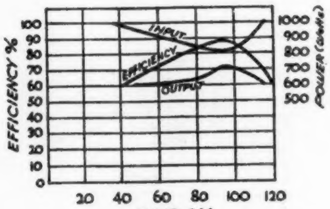


FIG. 3

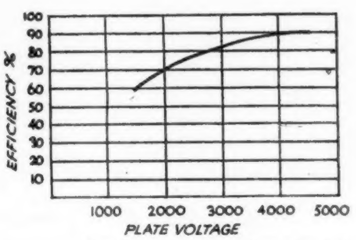


FIG. 4

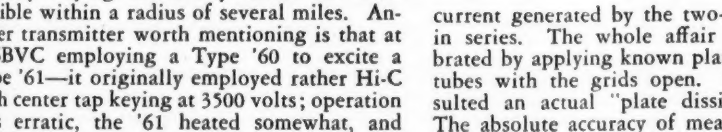
When using a Low-C output tank in which losses will be very low with the antenna drawing normal power, the output will be obtained with sufficient accuracy by merely subtracting the measured plate loss from the plate input. But as we wanted above all to determine the relationship between the LC ratio and efficiency, we have had to take into account the tank losses. Fortunately, it had been found during tests on the single wire fed Hertz that the effective feeder impedance at the station end remained constant and independent of the coupling. It was then a simple matter to determine this impedance from the feeder current and the value of I^2R, both obtained with conditions where the tank loss was negligible. The resulting impedance was approximately 600 ohms, a value applicable to most feeders of this type in calculating the output power. From this point it was not difficult to obtain curves showing the effect on efficiency of LC ratio, excitation, and plate voltage.

Curve number one in Fig. 2 shows the marked increase in efficiency with higher L even though the comparatively higher C end of the curve at 14 turns is considered Low-C by many. Actually, the L was not reduced further because the amplifier went into self-oscillation at lower values—even at 18 turns marked instability was noticeable. The total increase in efficiency amounts to 10%—a worthwhile gain.

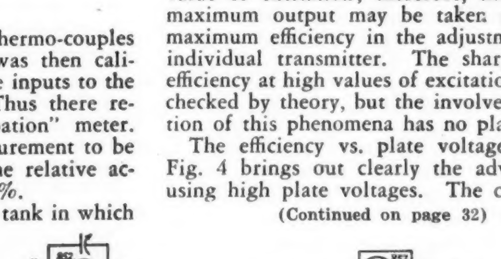
The curves in Fig. 3 are really the most interesting of the lot, for they emphasize the importance of correct excitation. The plate voltage was kept constant at 3100 volts, the antenna coupling also remaining fixed, while the excitation was varied. From a practical standpoint it will be noticed that both efficiency and output are maximum at the same value of excitation; therefore, the point of maximum output may be taken as that of maximum efficiency in the adjustment of an individual transmitter. The sharp drop in efficiency at high values of excitation is nicely checked by theory, but the involved explanation of this phenomena has no place here.

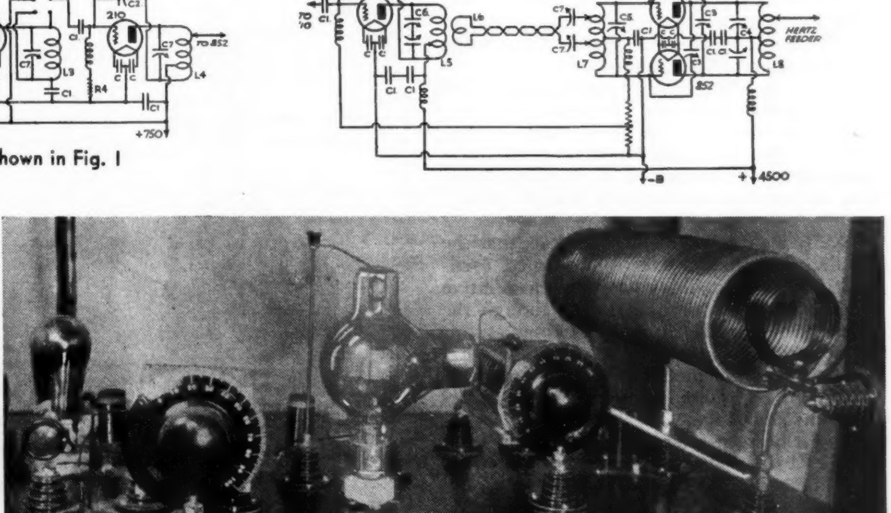
The efficiency vs. plate voltage curve in Fig. 4 brings out clearly the advantage of using high plate voltages. The curve itself

(Continued on page 32)



Circuit Diagram of Transmitter Shown in Fig. 1





. . . and "Still" Copper Is Cheap!

We Call It "The Gainer"

By CLAYTON F. BANE

"Lives there a man with soul so dead . . .
Who never to himself has said . . .
If there is more gain to get,
I'll get it instead"

●●●

THIS may be a broad paraphrasing of the age-old maxim, but certainly most of us have harbored such a thought. While specifically written around one particular receiver, this article contains some little hints that are applicable to any receiver using the same tube complement. Again, we are writing of a two-tuber—that much maligned little set, the mere mention of which is sometimes enough to cause one to snicker. This is unjustified, because it has been demonstrated, beyond question, that these little receivers, if properly designed, really do bring in the DX.

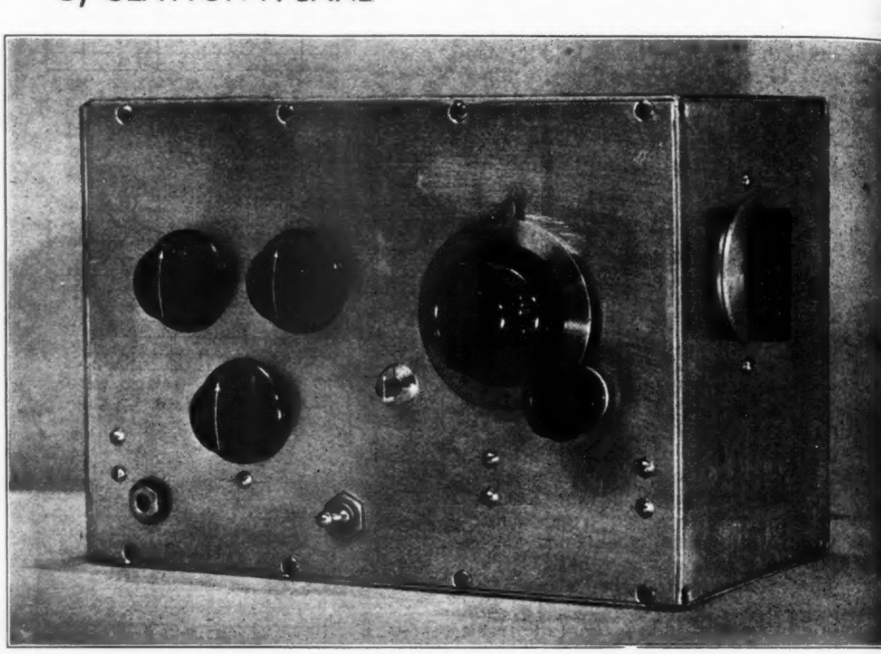
Numerous inquiries received since the publication of the previous two-tube receiver article in December "RADIO", have led us to the belief that there is a demand for such a receiver, but with additional improvements and refinements. The original receiver was deliberately made as simple as possible in order that many, who were unfamiliar with such receivers would have no difficulty in its construction. Electrically, we feel that the basic circuit was, and is very sound. Mechanically, of course, there was much to be desired.

Tests conducted with the more simple receiver indicated that improvements in mechanical features were desirable, these improvements justifying their addition by better over-all performance. Perhaps the most significant feature of the present receiver is its complete shielding, by using an aluminum shield can as the basic unit. The coil-change method was borrowed from the Bane-Hawkins super as this method allows the coils to be changed without removing the screwed-on top. The band spread condenser, usually troublesome because of hand capacity has been brought to the front of the panel by means of an insulating shaft without the slightest trace of this trouble.

Tone control and improved regeneration are incidental features. Basically, the circuit of the new receiver is the same as was used in the original two-tuber. Electron coupling has proved to be of decided advantage in autodyne circuits because of its frequency stability. This feature, however, is probably less important than the fact that the equalizing action of electron coupled oscillators makes it possible to work a regenerative detector right on the edge, even though the supply source (B eliminator) may suffer slight variations in voltage. Anyone who has tried to maintain this condition in other circuits with AC operated receivers will appreciate this advantage.

It will be seen after a look at the diagram in Fig. 1 that we have departed somewhat from the conventional circuit. The small bypass condensers usually shown on either side of the RF choke have been eliminated. Although used in practically all such receivers, in our case they were found quite unnecessary. Rather than helping the performance of our receiver, their use resulted in a noticeable decrease in volume. It should be said, however, that unless a good RF choke is used these condensers should not be omitted.

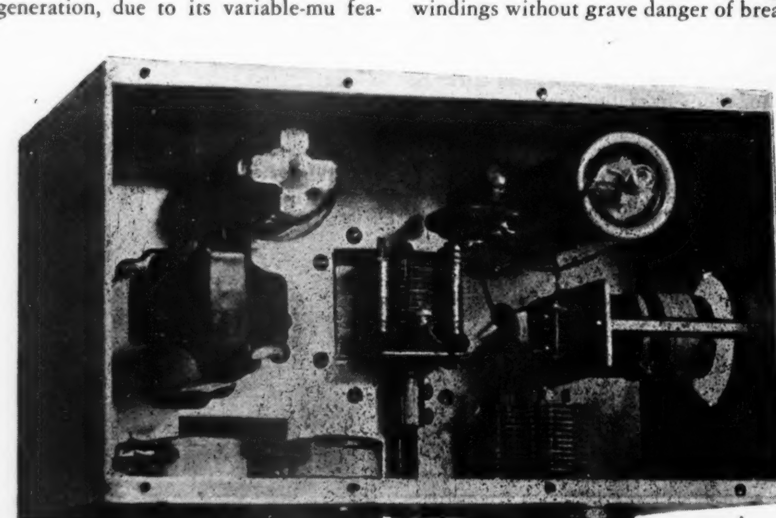
The tone control shown across the phones is a refinement that in our opinion is highly desirable. Especially is this true when pentode-type tubes are used in the audio. The tendency of these tubes to favor the high frequencies may result in a high-pitched hiss in the phones. The tone control, if of the correct value, simply passes these frequencies to ground, without much apparent drop in volume. In addition, the lack of highs in the output is sometimes advantageous in lessening external background noise.



"The Gainer"—Snugly housed in a completely shielded R. H. Lynch aluminum case. The plug-in coil greatly simplifies band-changing. The small controls on the front panel are, respectively, volume, tone and, below, the regeneration control. The small knob located between these controls and the main tuning dial is used to vary the capacity of the band-spread condenser, so as to get any desired degree of band-spread. The toggle switch cuts off the "B" supply.

Although a 57 tube is shown as the detector, a 58 might well have been used. These tubes are interchangeable and the 57 was selected simply because it gave slightly greater gain. It may be found that a 58 will give somewhat smoother and less abrupt control of regeneration, due to its variable-mu feature and the attendant gradual sloping-off of the bottom bend of its characteristic curve.

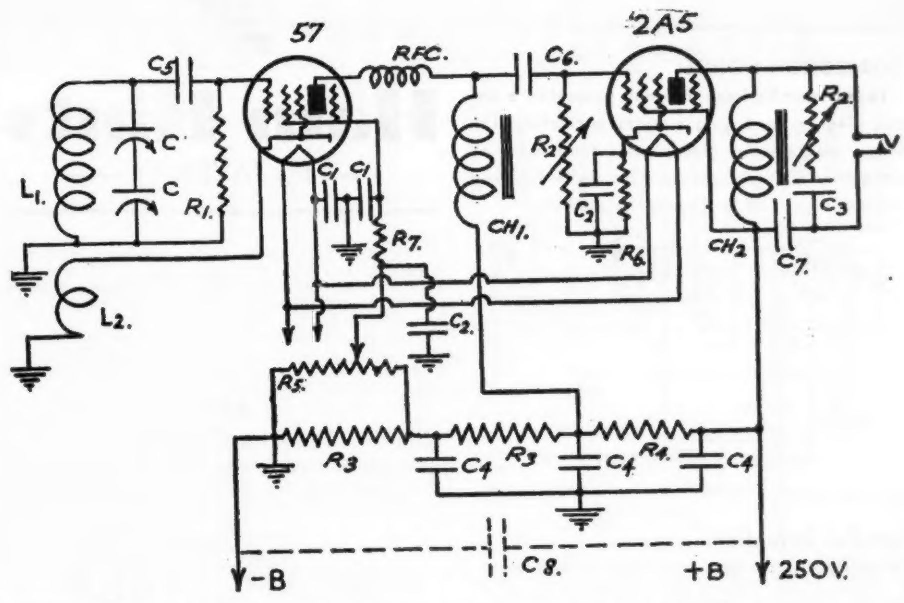
The use of a 2A5 in the audio stage was sanctioned only after very extensive tests with one in our receiver. High plate current, coupled with the fact that pentodes of this type can cause grief beyond description, means simply that certain precautions must be taken in order to make these tubes feasible. Methods employed with tubes like the 56 are, generally speaking, fertile sources of grief. In the first place, most high-quality impedances of the older types are not designed to carry more than a few mills through their windings without grave danger of breakdown.



Looking Down Into "The Gainer"—Note suspension and mounting of plug-in coil. The General Radio 200 Henry Coupling Impedance is at the far left.

The use of a 30 henry choke has been found to be perfectly desirable. These small chokes are made to carry much higher current. It is further desirable to keep the full DC plate voltage off the phones, which is accomplished by using a fixed condenser in series with the phone terminal going to the plate. The value shown (0.1 mfd.) may seem to be rather small, but higher values give only slightly better results, with a big increase in price. An output transformer for a pentode may also be used. The resistor from grid to ground in the grid circuit of the 2A5 serves as an excellent volume control, and its use is virtually a necessity if the operator values his ears. If the receiver is not to be totally shielded, by all means shield the 2A5. In this way, taking a precaution against nasty fringe howl which will only disappear if and when the volume control is retarded to the point where volume is worse than from a weak triode amplifier. With plenty of "kick" coming from the amplifier it is not at all unlikely that a troublesome hum will appear at the higher audio levels. A completely filtered power pack is one way to combat this trouble. Such a supply might consist of plate transformer, 80 or 5Z3 rectifier, double choke (30 henries each) and at least 30 mikes total capacity, split up, of course, before, between and after the chokes. Even with such a supply, in our case, total hum elimination came only after the input terminals to the B strip were shunted with an additional 8 mfd. condenser.

Having proven entirely successful in previous receivers, the series condenser band-spreader method was again incorporated. Its operation is made more convenient by bringing the band-spread control to the front of the panel, where it is readily accessible. This is possible by the use of an insulating shaft joined to the condenser by means of a regular brass coupling. A suitable bearing for the bakelite shaft termination on the front panel can be made by using a bearing from an old variable condenser made to pass a ¼-inch shaft. This band spread system calls for the use of two small condensers (100 mmf.) in series, one variable continuously and used for tuning, the other semi-variable and used for band spreading. When the capacity of the band spreading condenser is decreased, it has the effect of decreasing the capacity of the tuning condenser. This effect may be carried to the point where the minimum capacity of the main tuning condenser is equal to half the minimum capacity of the band spread condenser. This system has a further advantage in that the band spread condenser may be shorted-out and the full capacity of the main tuning condenser utilized, in this way providing much wider range of coverage than would be possible if this condenser were of the conventional three or four plate type.

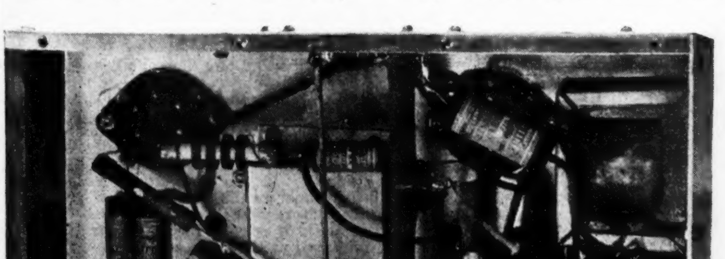


Legend & List of Parts for "The Gainer"

L1—20 Meters 8 turns of No. 22 DCC on 1¼-in. Genwin Form.
40 Meters 16 turns of No. 22 DCC on 1¼-in. Genwin Form.
80 Meters 32 turns of No. 22 DCC on 1¼-in. Genwin Form.
L2—(Wound on same form as L1, spaced about 3/16" from L1)
20 Meters 4 turns of No. 22 DCC
40 Meters 4 turns of No. 22 DCC
80 meters 4 turns of No. 22 DCC
C—100 mmf. Hammarlund Midget Variable (2 required).
C1—.01 mfd. Sprague 600 Tubular Condenser.
C2—.5 mfd. Sprague 600 Tubular Condenser.
C3—.1 mfd. Sprague 600 Tubular Condenser.
C4—.5 mfd. Sprague 600 Tubular Condenser.
C5—.0001 mfd. Sangamo Mica Condenser.
C6—.02 Sprague "Postage Stamp" Condenser.
C7—.1 mfd. Sprague 600 Tubular Condenser.
C8—8 mfd. Dry Electrolytic Condenser, Sprague.
R1—1 Meg. I.R.C. Grid Leak.
R2—500,000 ohm Variable Resistor, Electrad.
R3—10,000 ohm Ohmite Resistor.
R4—5,000 ohm Ohmite Resistor.
R5—50,000 ohm Centralab Potentiometer.
R6—500 ohm Ohmite Resistor.
R7—250,000 ohm I.R.C. Resistor.
CH1—General Radio 200 Henry Impedance.
CH2—30 Henry Choke, United (or output transformer).
RFC—GOOD h.f. RF Choke.
Also required—1 R. H. Lynch Aluminum Shield Case, 6x7x10, Type B.

This system may be considered to have a disadvantage in that the adjustment of the band-spread condenser is rather critical. During adjustment, move the band spread condenser very slowly, beginning with the maximum capacity. Set your main tuning condenser to the point where you want the edge of the band to fall on the dial. Better find a commercial "marker station" near this point. Now move the band-spread condenser until this commercial appears on the main tuning dial at the position where you desire him to be. Again a word of caution . . . move the band-spread condenser **slowly**, and don't be afraid to add turns to the grid coil if your marker falls off the main tuning scale. By following the dimensions given for the coils, no trouble should be experienced in finding the bands.

The already-quiet regeneration control, as used in the original receiver, has been made more quiet by a little circuit trick. It was found during some extensive tests that the small condenser used to by-pass the screen to ground (necessary for electron-coupling), was too small to calm down the noise in the regeneration control. Ordinarily, it was necessary to try several types of potentiometers for this purpose before one could be found that was reasonably quiet. A larger by-pass condenser, if it could be used, would make even the poorer types work nicely. However, this larger capacity, if used, would have such a great by-passing effect on the audio component as to make its use impossible. By using the original small capacity in its function of maintaining the screen at RF ground potential, and adding a quite large value of resistance in series with the lead to the mid-arm of the potentiometer, an effective isolation circuit was established. It was then possible to add the larger capacity necessary to keep the regeneration control quiet at the power supply end of this resistor, without by-passing any more of the signal to ground. It is possible that a smaller value of series resistance could be used so as not to cause such a large voltage drop to the screen. This is no disadvantage in our case because it is merely necessary to advance the regeneration control to compensate for the drop.



Bottom view of "The Gainer" with base plate removed. The audio coupling impedance is at the extreme right rear corner. The "B"-strip resistor (3 small Ohmite Red Devils) run vertically across the base. Note isolation of of the detector circuit (to the left).

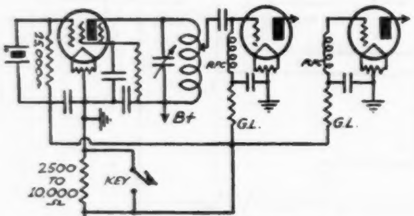
While possibly not providing the very ultimate in weak signal sensitivity, the 1-meg. resistor used as a grid leak has some advantages that more than offset this one disadvantage. In the first place, it renders the detector much less liable to blocking by strong locals. Secondly, its use has been found to be greatly beneficial in the elimination of fringe howl. This fact has allowed the use of a large resistor for the volume control with an attendant greater audio output. With higher grid leak values the howl occurs with the volume control well retarded.

The separate cathode coil version of the electron coupled circuit has been selected in preference to the "Hartley" version. Its use allows a separate winding for the cathode-grid coil instead of the tapped coil necessary in the other circuit. On high frequencies, this latter method has the disadvantage not only of the tap, but also because of the fact that the placement of the tap is very critical.

(Continued on page 31)

CORRECTION NOTICE!

In last month's issue Jayenay presented a circuit diagram for keying a crystal oscillator. The wrong diagram was given, one intended for an altogether different article. Herewith is shown the correct circuit for keying the oscillator.



Push-Pull Detection

PRACTICALLY every high-frequency superheterodyne produces more noise in the phones when the beat frequency oscillator is turned on. This noise is partly due to oscillator hiss and partly to noise produced in the detector itself. Much of this unwanted noise can be eliminated by the use of push-pull heterodyne detection as shown in Fig. 1.

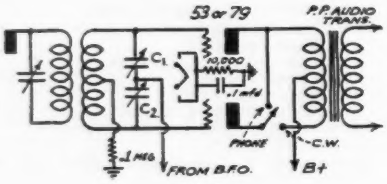


FIG. 1

This form of detection is highly efficient and almost immune to overload, due to the differential action of push-pull. It requires more RF voltage from the oscillator than usual. The oscillator must be well shielded, so that none of the oscillator output is picked up by the first IF tube and amplified through to the second detector, where it would be applied to the detector grids in push-pull instead of in parallel, as shown. This condition would lower the sensitivity and bring back the noise we are trying to eliminate.

Note that all signals are applied in push-pull while the oscillator output is applied in parallel to the two grids. The two halves of the detector must be matched, so if two tubes are used in place of the 53 (or 79) shown, it is imperative that their characteristics be nearly identical. Any mismatch of the two halves of the circuit will manifest itself by an increase in noise when the oscillator is switched on. It will be hard to get perfect balance, but even approximate balance effects a great improvement in the signal to noise ratio.

The purpose of the two condensers C1-C2 is twofold. First, with the BFO turned off, they are used to tune the secondary of the IF transformer to resonance, at which time the oscillator is switched on. Then the condensers are varied, in opposite directions, until the oscillator output is applied equally to both grids, meanwhile maintaining the circuit in resonance. When the point of proper adjustment is approached, the noise output of the second detector will start to decline. Therefore, the optimum adjustment is one which gives minimum noise and maximum signal.

The center-tapped secondary is only necessary to provide a DC return to the grids. Two RF chokes in series, across the grids, with the center-tap grounded through a decoupling resistor, will give the same result, although there will be some loss through the chokes. Do NOT try to feed the RF from the oscillator to the center tap of the coil, as you are almost certain, thereby, to feed more RF to one grid than the other, which unbalances the circuit. The two condensers C1 and C2 represent a very simple means of balancing the heterodyne detector and each should be twice as large as the single trimmer that they replace. Two of the ordinary trimmers in series will sometimes do the job if the IF amplifier is lined up at a frequency which allows rather low C to be used. Air dielectric condensers show up to good advantage at this point, but good results have been obtained with the mica type of trimmer.

If everything is balanced and shielded properly, you should hear no signals, modulator or otherwise, with the BFO turned off. If signals are heard something is out of balance, somewhere. By the same token it is impossible to receive phone signals with this type of detection until we connect the two plates in parallel. The simple switch shown does this very effectively. In the phone position the circuit resembles the conventional Wunderlich detector.

Ham Hints

—— By JAYENAY ——

The diagram shows plate detection, although grid-leak detection has been used with success in this circuit. By grounding the cathode directly we have grid detection with the 100,000 ohm decoupling resistor acting as grid leak.

This same circuit works equally well as the first detector in a super, but the problem of balancing and shielding the high frequency oscillator output adds numerous difficulties.

●●●

Oscillator-Detector Coupling

THERE are hundreds of ways in which the RF voltage from the high-frequency oscillator can be coupled to the first detector. Fig. 2 shows one

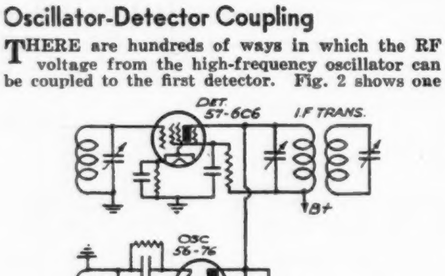


FIG. 2

method which works especially well on frequencies clear up to 75 megacycles. This system is very free from "interlocking tuning" effects, but requires a full 250 volts on the oscillator plate, rather than the 100 volts commonly used. However, this is not a disadvantage, but better shielding around the oscillator is sometimes necessary. It will be noted that the oscillator shown in the diagram is a triode in the conventional Hartley circuit.

This coupling method is entirely suitable for electron-coupled oscillators, although little increase in stability will result and the electron-coupled Hartley is very cranky above 25 megacycles.

The potentiometer R1 provides a convenient means of varying the coupling, as it is almost impossible to use the same coupling at 2 megacycles that is necessary at 30 megacycles.

●●●

Another Answer to the Grid Choke Problem

THE grid choke, as used in impedance-coupled transmitting amplifiers, has long been recognized as a prolific source of grief. All non-resonant chokes usually cause a material loss of excitation and resonant chokes are apt to burn up, unless made of very heavy wire or copper tubing. The circuit shown in Fig. 3 represents a variation of an old Western Electric circuit and is notable

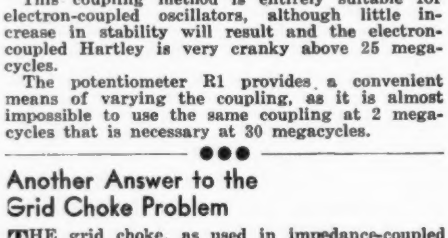


FIG. 3

for its simplicity, as well as efficiency. The choke problem is eliminated, due to the use of series-feed to both plate and grid. However, the main advantage of this circuit is its extremely good L to C ratio. Note that no tuning capacity is shunted across L1-L2, which is tuned to resonance by varying the coupling between L1 and L2. This variation of coupling varies the total inductance and effectively tunes this tank circuit, whose shunt capacity consists of the distributed capacity of the two halves of the coil (L1 and L2); and the neutralizing condenser C1 and the plate to grid capacity of the 211 tube, which two capacities are in series across the tank coil.

This extremely high L to C ratio allows the 46 doubler to operate at maximum efficiency and output, due to the high load impedance which is essential for satisfactory doubler operation. This circuit is applicable to any RF amplifier, whether a doubler or not. Because the output capacity of the power supply filter is shunted across C3, it sometimes becomes necessary to place a small RF choke in the B plus lead to the 46, in order to make the note PDC. However, this choke has very little work to do and its dimensions are not critical.

This method of coupling is not claimed to be as efficient as the link coupling method developed by Messrs. Lytton and Bane, but its simplicity makes it very attractive.

●●●

Keep Your Rectifier Tubes Away From Strong Radio Frequency Fields

IT has been found that strong RF fields can cause 866's and other mercury vapor rectifier tubes to fail, even when lightly loaded. Therefore, it behooves us to either shield our rectifiers or keep the power supply well away from the RF portion of the transmitter.

●●●

Peak Emission

MANY inquiries have been received regarding the relation between the peak filament emission current and the safe operating plate current, which is read on the usual plate milliameter in a vacuum-tube amplifier. Because most vacuum tube circuits are engaged in amplifying some form of alternating current, it should be evident that the space current in the tube is not constant, but varies up and down over each cycle of excitation applied to the control grid. Provided we do not exceed the normal plate dissipation of the tube under consideration, the average value of this space current may be as high as we care to make it, PROVIDED that the PEAK plate current NEVER exceeds the rated peak emission current. The rated peak emission current depends on the watts of electrical power used in heating the filament or cathode, and on the efficiency of the particular cathode material as an electron emitter.

The ratio of peak emission current to the observed space current is lowest in a class A amplifier which is engaged in amplifying a sine wave. In this case, the peak current can be as low as 2.4 times (approximately) the observed space current. This ratio reaches quite high limits in a high-efficiency class C amplifier which is characterized by high bias, high excitation and high plate voltage. A study of the plate current plotted against time, on a graph, shows us that plate current flows for only a very small portion of each cycle, and, during this extremely short period of time, can reach a very high peak value. However, because the plate milliameter averages the plate current over one complete cycle, the observed value may be quite low. It is entirely possible for the peak space current to exceed 200 times the observed value on the plate milliameter. Thus it is evident that any given tube can be operated at a much higher value of plate current in class A or class B than in class C, without danger of loss of emission. It should be noted that grid current (intercepted by either the control grid or a screen grid) subtracts from the plate circuit's allowance of total space current.

●●●

The Mystery of the Missing Stand-Off Has been Solved

W1HE, Wallace A. Battison, 12 Osborne Road, Arlington, Massachusetts, has been judged the winner of the W6QD-W6CUH Mystery contest, as announced in November "RADIO". To him goes the prize . . . the missing part, which the artist inadvertently omitted from the station photo. 'Twas a humble stand-off insulator, the one used to hold the far end of the final tank coil in position. Indeed, the photo shows that the tank coil is supported by two stand-offs, but one is in the middle of the coil, the other at the near-end. Strange, but only one man, in more than 600 who entered the contest found the missing stand-off. So, to W1HE, Arlington, Massachusetts, goes the stand-off insulator, as soon as CUH-QD can comply with the request of the winner that the stand-off insulator be autographed. If the Manhattan Beach folks can't devise some means to autograph a glazed-porcelain insulator, we will commission E. F. Johnson Co. to build a special insulator for the prize winner, unglazed at the base, so that autographing will be an easy matter. Thus, W1HE, you thought you fooled us, didn't you? Come clean, now!

●●●

Some Data On the '46

WHEN the two grids of the '46 are tied together the tube operates without bias. When tied together the two grids increase the amplification of the tube and there is almost negligible space current flow without bias.

●●●

What Tube Has Replaced the '45?

BECAUSE it is a more efficient tube, the 2A3 is replacing the '45 in audio amplifiers. Furthermore, the 2A3's are much less subject to distortion. The 2A3, self-biased, gives 10 watts output in a push-pull circuit, whereas the output is increased to 15 watts when fixed bias is used.

Practical Grid Modulation

By JACK HOLMES (W6BUY) and FRANK C. JONES (W6AJF)

MANY amateurs who have well filtered CW transmitting sets have thought about the use of phone on one or more of their assigned phone bands. Usually after figuring up the cost of a 100 to 500 watt modulator, the amateur decided, that after all, CW was by far the most fun and that he really didn't want to use voice transmission anyway. A class A or class B modulator that will deliver even 50 watts of audio power for an RF amplifier input of 100 watts, costs, with its power supply, as much as a good CW transmitter. An RF amplifier input of 100 watts usually means from 50 to 70 watts of carrier frequency power, so it is necessary to figure nearly as much audio power as one wishes to have of RF power in the antenna.

Class B linear RF amplifiers following a plate modulated class C stage of low power offer possibilities, but the relative carrier power with respect to the size of the class B RF tubes isn't too good as far as amateurs are concerned. Nothing sounds much worse than an incorrectly adjusted class B RF amplifier when it is handling modulated signals, so this fault also tends to scare away prospective amateur phone operators.

The remaining modulator possibilities are those using some form of grid modulation. There is one form which has been used at W6BUY very successfully on 20 meter phone, using a pair of 242A's in the final amplifier and modulated by a type 71A tube. The modulation can be run up to 100% easily, and the reports from listeners have always been of very good quality. When it is correctly adjusted, this form of grid modulation is supposed to have low values of distortion up to 100% modulation, which is less than most plate modulated amateur phone stations seem to be able to attain. Certainly the quality is good enough to warrant the use of the best type of microphone that the amateur can afford to use, and some thought should be given to room acoustics. It is possible to modulate the full one kilowatt input to the final amplifier with less than 10 watts of audio power available, such as can be obtained from a pair of class A prime 245's or 2A3's.

The method used at W6BUY for adjustment of the modulation scheme shown in Fig. 1 is as follows: The final stage grid-bias battery is set for normal cut-off value, that is, the normal load plate voltage of say 1200 volts divided by the mu of the tube, which is 12, to give 100 volts C bias. Most power pack voltages rise when the final amplifier is adjusted to zero plate current or cut-off, which might require 125 volts or so to actually bring the plate current to zero. Result is that it is usually better to use the manufacturer's tube rating of mu and the normal plate voltage under load conditions for figuring the cut-off and 1½ times cut-off bias. The RF input is then adjusted so that a little grid current flows, normally about 3 M.A. This adjustment is done by adjusting the input to the 210 doubler stage so its output is just the right amount. Next the final amplifier bias is raised to 1½ times cut-off, or 150 volts negative C bias. The audio output of the 71A tube is then adjusted for enough to cause kicks in the grid current and very decided increases in plate current. The latter will increase nearly 50%, since this might be called a constant voltage instead of constant current modulation system. The plate current at W6BUY is normally 125 M.A. and at 100% modulation it increases up to about 185 M.A. The antenna current increases as it does with plate modulation. A couple of peculiar effects were noticed at this station, such as the need of the proper winding direction on the modulation transformer. A reversal of this winding seemed to cause a dip in antenna current while modulating. Whether it was due to transformer core saturation or some RF feedback, hasn't been determined.

The modulator tube should have a low plate impedance, such as a 71A or 245 tube, and the modulation transformer can be a 1:1 or 1:1½ step-up ratio with fairly low resistance windings. An old magnetic loudspeaker output transformer which has primary and secondary resistances of not over 500 ohms or so, works satisfactorily. The amount of speech amplification ahead of a 71A depends upon the type of mike, the one used at W6BUY has two stages of 201A's. At W6AJF a single stage with a 205D tube was used, with a single button mike. This modulated a pair of 210 tubes when talking close to the mike.

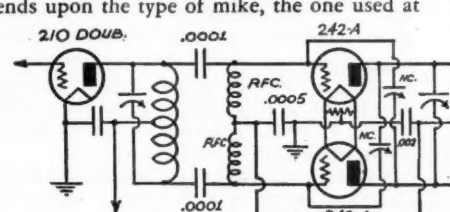


Fig. 1

The C batteries can be by-passed with a 2 mfd. condenser, and a series audio choke placed in one lead if the leads to the batteries are exceedingly long. The RF by-pass condenser across the RF grid return can be of any value between .0001 and .0005 so as not to appreciably affect the audio quality.*

The circuit shown in Fig. 1 is for a pair of "fifty watters" but a single tube may be used, and other schemes may be used for RF coupling to the preceding buffer or doubler-buffer stage. If link circuit coupling is used,* the RF grid excitation can be controlled by varying the power stage grid tuning condenser and by variation of link circuit coupling. A type 59 tube or a 210 will drive one or two 211's or 242A's for phone operation, since somewhat over 100 volt peak swing is necessary from the RF driver and 50 volts audio swing from the modulator.

The modulator must supply a small amount of power because a little grid current flows, especially on peaks. This also means that a 1 to 1 or 1:1½ step-up ratio modulation transformer is usually desirable, since the load on the modulator will be more constant over the whole modulation period. A load resistor of 10,000 to 50,000 ohms across the modulation transformer secondary would probably reduce modulator percentage distortion.

C battery bias seems to be quite necessary; a grid leak for bias would not be possible, nor could cathode or center-tap resistor to ground be used. The latter would provide a variable grid bias since the plate current varies about 50%. If the CW transmitter normally uses a grid leak in the final stage, it should be shorted out, if any grid current is to be drawn.

The all-important question of efficiency arises in connection with any form of modulation. Recent tests at W6PB by Dan O'Brien, Clarence Stevens and the writer, gave some interesting results which will probably be covered in more detail in a forthcoming article. Some of the figures are given because his transmitter also uses a pair of 242A tubes in the final stage with a 210 buffer or doubler driver. These tubes were to be operated at about 1400 volts plate potential, so cut-off grid bias would be $\frac{1400}{\text{mu}} = 117$ volts. 1½ times cut-off for normal phone operation would then figure to be 175 to 180 volts. The Western Electric method of operation, which is RF input to just draw grid current at cut-off bias, then raise bias to 1½ times cut-off with the audio swing just below the kicks of grid current, gave an output of about 10 watts carrier. This was for a plate input of about 70 watts with no modulation. The efficiency was less than 15 per cent.

The method used at W6BUY, and other amateur stations now, is to use 1½ times cut-off bias but increase the RF input until a little grid current flows, anywhere from 1 to 5 M.A. The efficiency increases remarkably, running from 41% to 69% of carrier output to plate input on the 20 meter band. The method of measurement was to read plate voltage and current, and RF current through a dummy antenna load of different lamps of 25 to 100 watt ratings. The latter were connected across the 115 volt AC line with the same RF ammeter in series in order to get the current reading for normal power dissipations of 25, 40, 60 and 100 watts. These lamps were used at that same current reading coupled by 2 or 3 turns to the final amplifier tank circuit to simulate an antenna load. This method isn't exact, but is probably fairly accurate since the lamps were only used at their rated current and illumination values.

Without good neutralization of the final amplifier and the tank circuit tuned for minimum plate current, we get efficiencies as high as 69% on 20 meters and 62% at 40 meters, with about 5 M.A. of grid current and a negative C bias of 180 volts. Apparently the regeneration aided the efficiency and the crystal oscillator locked-in the frequency of oscillation. With good neutralization, the efficiency ran from 41% with 1 M.A. of grid current at 1½ times cut-off, to 62% at 10 M.A. of grid current. At good neutralization, the greatest dip of plate current coincides with maximum antenna current. Apparently the efficiency can be run as high as 50% with grid modulation if high plate voltage, low C tank circuit, and slight continuous grid current values are used.

At W6JER successful grid modulation of this type was obtained with a pair of 210 tubes on ten meter phone with 600 volt plate supply, 3 M.A. grid current, with peak grid currents of about 10 M.A. The plate current was normally about 60 M.A. with nearly 50% increase on audio peaks. The C bias was 135 volts.

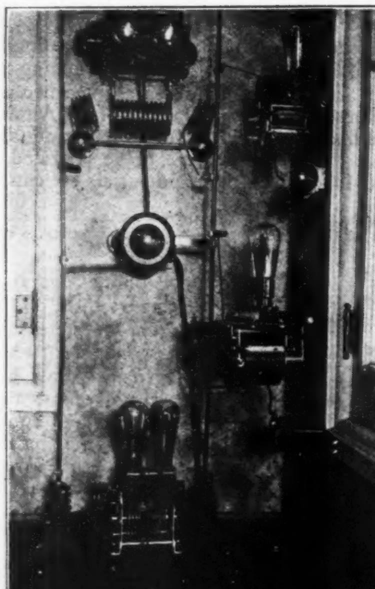
At W6AJF, preliminary tests with a 204A final stage amplifier indicated that with this

(Continued on page 27)

*The .006 condenser usually used with Link coupling would be too large—resulting in too-great by-pass of audio to ground.—EDITOR.

Globe Girdlers

Conducted by CLAYTON F. BANE, W6WB



"They crawl up the wall like flies", W6FFP's Transmitters

—W6FFP—

CLYDE C. ANDERSON

Fresno, California

By way of contrast, this month we are pleased to present the station of Clyde "Andy" Anderson, ex7JF, exNA7AD and now W6FFP.

Most certainly, when a station using as low power as this station uses and can work the DX that Andy has, it is most fitting that he be given proper recognition for his work.

Using a pair of 45's in push-pull, with an occasional lapse into the high-power field with the substitution of a pair of '10's, Andy has recently completed his two-hundredth QSO with ZL1AR. These QSO's have been on three bands, 40, 80 and 160 meters. This feat makes both of these stations eligible for membership in the TBTOC, Three-Band-Transocean-Club, which is no mean feat considering the power used.

Separate small self-excited transmitters are used for each band and this system facilitates a very rapid shift from one band to the other. One photo shows a snap of these little rigs. The photo opposite is a close-up of the transmitter at ZL1AR, and by looking closely one can see the very fancy QSL card from W6FFP which was sent to celebrate the two-hundredth QSO.

Andy's walls are loaded down with various momentos that the gang have sent him from all parts of the world, from Australia and New Zealand in particular. ZS2F was original in his gift, sending an ostrich egg to celebrate W6FFP's first ZS QSO. A little silver KIWI bird is ZL1AR's contribution to the station trophy collection.

A directional antenna is used but, peculiarly enough, it seems to work equally well in any direction. Proving this point, it might be said that Andy succeeded in working WAC during the recent international tests. This in addition to working 14 different prefixes. As he himself says, "I was only 126th in the total of 750 entered in the U. S." HI!

The FBX-A holds down the receiving position. Perhaps the location is somewhat unusual, but nevertheless the fact remains that this station hears enough DX on 80 and 160 meter bands to make some of the 40 meter gang jealous. Yep, he hears 'em—and also works 'em.

Take a look at the old boy himself in the bottom right-hand corner. In case you can't read the calls, Andy is the second on the right in the bottom row. Incidentally, he certainly did lower the power average in that group, which might well be called the "W6 Power Trust"! This photo was taken at a recent convention of the Pacific Division. It has been estimated that an average, taken for the group in the foto, would run about 1 KW per man!

An unconfirmed rumor just hot off the grapevine leads us to believe that Andy, like many others, has been bitten by the high-power bug. We think perhaps the new 800 or 354 may be his choice.

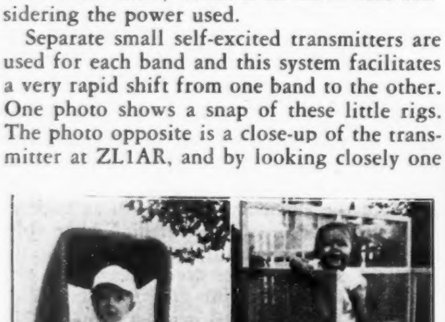
It is regrettable that no complete list of DX countries worked are available because we know this list is very imposing—particularly in view of the fact that W6FFP has used such low power.

Andy Anderson's Aristocratic Antenna Altituding Airward

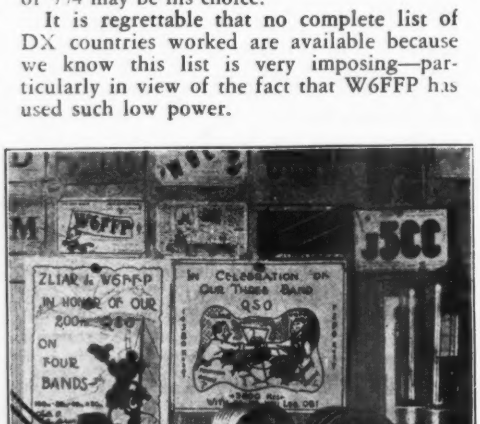
• • •

. . . And Now We Pass the Buck . . .

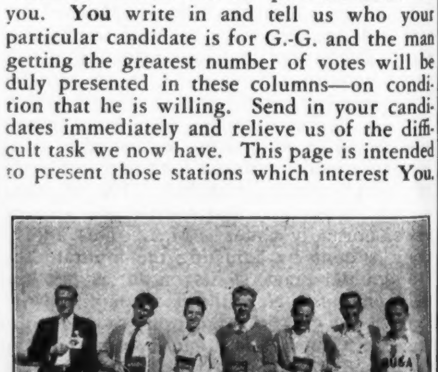
Conducting a department like "Globe Girdlers" is no easy job. The one thing that makes it particularly difficult is the fact that there are so many outstanding DX'ers to choose from. Certainly, merely being WAC is hardly justification enough to make the station owner eligible. With the right location, WAC is not a difficult matter. Knowing that there are dozens of stations in the United States and abroad that have done much outstanding work, and realizing the futility of any one man knowing about them all, "RADIO" would like to "pass the buck" to you. You write in and tell us who your particular candidate is for G.-G. and the man getting the greatest number of votes will be duly presented in these columns—on condition that he is willing. Send in your candidates immediately and relieve us of the difficult task we now have. This page is intended to present those stations which interest You.



Imagine calling this poor little innocent child "RCA"! Yet RCA, in this case, is interpreted to mean R. C. Anderson, progeny of W6FFP



ZL1AR, Auckland, New Zealand, Globe Girdler Par-Excellence



Top Row, left to right: W6FT, W6BGW, W6WB, W6MV, W6CAL, W6QD, W6CUH. Bottom Row, left to right: W6BYB, W6ETR, W6DD2, W6FFP, W6AAR

Another Effective Antenna System

By FRANK C. JONES, W6AJF

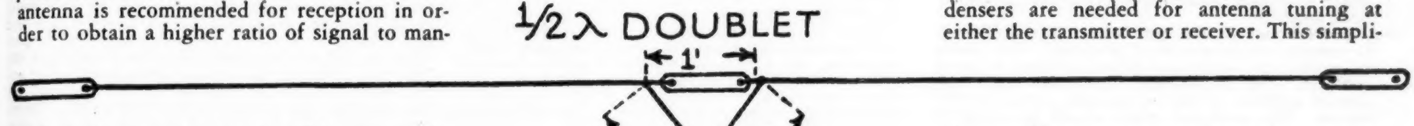
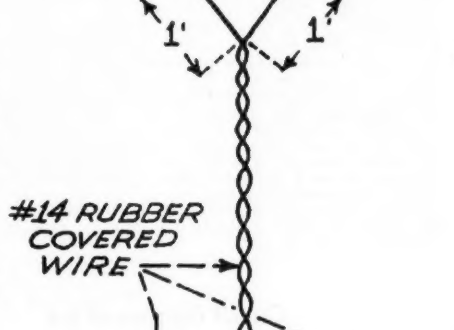
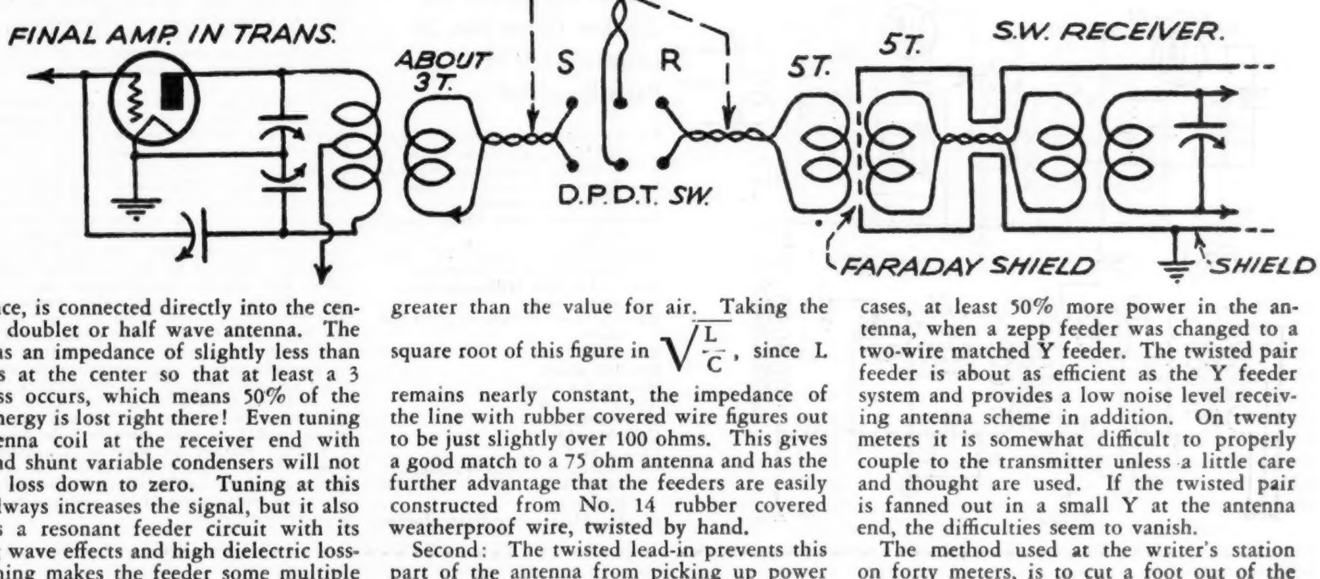
MUCH has been written on the subject of antennas and their attendant feed systems and quite likely, the end is not yet in sight. Practically obscured by the smoke raised by the enthusiasm over some of the more recent versions, the twisted pair feed line has not received the recognition it deserves. It is hoped that the following paragraphs may help to pick it up out of the discard and put it up in the front ranks—where it belongs.

In most stations separate antennas are used for transmitting and receiving. The reason for this is apparent. As an example, a transposed lead-in feeder to a half wave doublet antenna is recommended for reception in order to obtain a higher ratio of signal to man-made-static or noise level. This antenna is usually used in conjunction with another, using either a single wire or zepp feeders, for transmitting. These two transmitter feeder schemes are power wasters and are popular, either because of ignorance as to their losses, or because of the ease of switching from one band to another. (Operation on harmonics).

In receiving, the transposed feeder scheme is also a prolific source of signal loss. A fine illustration of this statement is where a transposed feeder of approximately 450 ohms impedance, is connected directly into the center of a doublet or half wave antenna. The latter has an impedance of slightly less than 75 ohms at the center so that at least a 3 D.B. loss occurs, which means 50% of the signal energy is lost right there! Even tuning the antenna coil at the receiver end with series and shunt variable condensers will not cut that loss down to zero. Tuning at this point, always increases the signal, but it also gives us a resonant feeder circuit with its standing wave effects and high dielectric losses. Tuning makes the feeder some multiple of a half wave in length which eliminates the reflection loss and accounts for the great signal increase, but we have greater line loss so that the efficiency is not increased as much as could be desired.

A twisted-pair feeder is non-resonant and yet matches the center impedance of a doublet antenna closely. The line loss is there, since a solid dielectric is used to separate the two feeder wires, but the voltages in either transmitting or receiving are so low that the losses are less than for an air spaced resonant feeder system. I believe that a little common sense thinking will show the desirable features of a twisted feeder antenna system. Consider the following points:

First: The impedance match to the antenna is good so the line doesn't have to be tuned with series and shunt condensers at the receiver antenna coil. The impedance of an air-spaced line is given by the formula, $Z = 276 \log_{10} \frac{2D}{}$. If two No. 14 wires could be spaced $\frac{3}{16}$ of an inch, in air, the value of Z would be 211 ohms. For a line of this type (twisted pair), the impedance is nearly proportional to $\sqrt{\frac{L}{C}}$, where L and C are the distributed values. The value of C would be increased from three to four times, due to the fact that the dielectric constant of rubber is that much greater than the value for air. Taking the square root of this figure in $\sqrt{\frac{L}{C}}$, since L remains nearly constant, the impedance of the line with rubber covered wire figures out to be just slightly over 100 ohms. This gives a good match to a 75 ohm antenna and has the further advantage that the feeders are easily constructed from No. 14 rubber covered weatherproof wire, twisted by hand.

Second: The twisted lead-in prevents this part of the antenna from picking up power noises and so gives excellent signal-to-noise ratio. For either transmitting or receiving, the capacity of both feeders to ground or other objects, such as stucco wire screening in some houses, is balanced, resulting in no capacity currents to ground with their attendant losses.

Third: The twist can be made uniform throughout the RF feeder making the distributed constants of the line uniform, which is not so for a transposition block type of feeder system, where the wires are parallel for 2 or 3 feet and then cross over. The dielectric loss of the twisted feeder is probably slightly greater, but the voltage is only ¼ or ⅓ of that in a non-resonant air-spaced line so that these losses are nearly negligible.

Fourth: The same antenna can be used for both transmitting and receiving by the use of a porcelain based, small DPDT knife switch. To obtain the benefit of the directional characteristics of doublet antennas, two can be put up, one north and south, and the other east and west. The antenna which gives the best received signal at that time should also be used for transmitting.

Fifth: The harmonic radiation efficiency is low, which minimizes the second harmonic from your transmitter. This may be a disadvantage for multi-band operation but what do you care if you can put twice as much "zoup" into the air and raise twice as much. These antennas are simple to construct and one can be put up for each band normally used. Sixth: No series or shunt tuning condensers are needed for antenna tuning at either the transmitter or receiver. This simplifies receiver tuning and still gives as good signal pick-up as the transposed tuned feeders (or tuned zepp feeders). In transmitting, it eliminates an additional tuned circuit loss and by actual measurement, puts 25 to 50% more power into the antenna!

Seventh: The feeders can be run around corners of the house and no particular care need be taken such as is necessary with an air-spaced two-wire feeder or zepp feeders. The length, of course, is not critical at all.

Measurements at two locations with 20-meter type doublet antennas showed in both cases, at least 50% more power in the antenna, when a zepp feeder was changed to a two-wire matched Y feeder. The twisted pair feeder is about as efficient as the Y feeder system and provides a low noise level receiving antenna scheme in addition. On twenty meters it is somewhat difficult to properly couple to the transmitter unless a little care and thought are used. If the twisted pair is fanned out in a small Y at the antenna end, the difficulties seem to vanish.

The method used at the writer's station on forty meters, is to cut a foot out of the center of the half wave doublet and fan the twisted lead-out for a foot, making a small equilateral triangle with a couple of small insulators at the center of the antenna. Using a 204-A final stage amplifier, the junction to the antenna got slightly warm when the twisted pair was cut directly into the center of the antenna. The heating effect disappeared and the field strength around the antenna was increased when the small Y connection was installed.

The coupling to the transmitter is simple. It can consist of three to five turns of the same rubber covered No. 14 wire wound tightly around the nodal point of the output tank circuit coil. This coupling coil should be tapped at each turn so that the feeders can be connected across enough turns

(Continued on page 29)

Radiotelephony

By "LINEAR"

The Junkbox Phone—No. 2

LAST month in these columns was described a 160-meter phone which represented the acme of simplicity. It used one 2A5 as crystal oscillator and a second 2A5 as modulator. Herewith we show the first step toward more power and improved performance. A push-pull final amplifier has been added. It utilizes two 2A5's, and the modulation capability approaches 100% due to the use of four 2A5's in parallel as modulators. A 56 is used as an audio amplifier in order to allow the use of a close-talking double button mike, which is an improvement over the single button mike used in the earlier transmitter. Note that "Link coupling" is used between the oscillator and the modulated amplifier. This is essential in order to obtain enough excitation for the modulated amplifier.

Construction of the transmitter is not difficult, if certain points are kept in mind. Use plenty of mechanical seperation between stages to avoid feedback, and, if possible, shield the audio frequency portion of the transmitter from the RF stages. The push-pull stage should be perfectly symmetrical and the leads carrying RF should be as straight and as short as possible. Note that the "feed line" is coupled to the "cold" (grounded) end of the oscillator plate tank. Experiment will quickly show the best degree of coupling which provides maximum excitation, yet still allows stable operation of the crystal. The modulation choke is center-tapped and should be as big as possible for good quality.

There is only one critical adjustment in the whole transmitter, namely the antenna coupling to the final amplifier. The plate current of the final amplifier varies with the antenna coupling, and thus the coupling must be varied until the load resistance represented by the final amplifier equals 7000 ohms. With a plate voltage of 350 volts the antenna coupling must be varied until the final draws EXACTLY 50 milliamperes, no more and no less.

The 7000 ohm load represented by the modulated amplifier is transformed into a 1750 ohm load on the four 2A5's in parallel, due to the four-to-one impedance step-up in the center-tapped modulation choke. This 1750 ohm load is just right for the four 2A5's, and they will run well inside of their ratings in order to minimize the distortion which often accompanies the operation of pentodes in parallel. At this point I might note that the resistor R4 is for the purpose of preventing parasitic oscillation of the modulators; four of these resistors are necessary, one in each grid lead. The five meter jacks add little to the cost of the transmitter and help materially in tuning up and locating trouble, should it occur. J2 measures the grid current of the final amplifier and is a measure of the excitation being applied to the push-pull grids. Anything above 10 milliamperes is satisfactory at this point. As stated above, the plate current (with 350 volts plate voltage) of the modulated amplifier measured at J3 should be EXACTLY 50 milliamperes. The other plate currents will vary, depending on individual tubes and power supplies but it should be remembered that NO VARIATION in any of the currents is permissible during operation of the transmitter. Any variation means distortion. Always remember that **quality works more DX than quantity.** For those who wish to build a portable transmitter using this circuit, remember that the 42 and the 2A5 are identical except for the heater voltage. The 2A5 has a 2½ volt heater and the 42 has a six volt heater. The RK 17 can also be substituted for the 2A5 by connecting the control grid lead to the cap at the top of the RK17. Otherwise the RK17 is practically identical in characteristics with the 2A5.

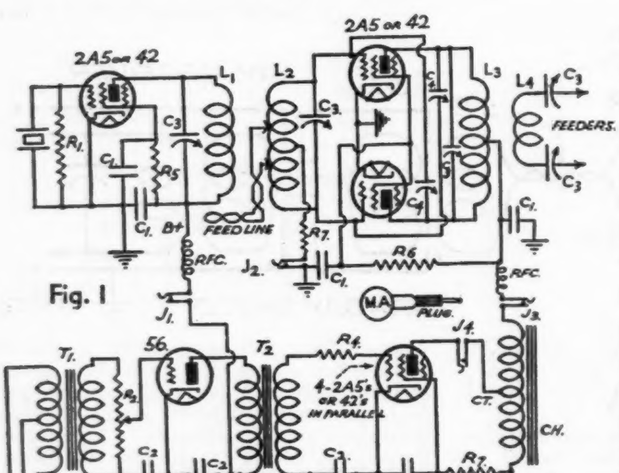


Fig. 1

Circuit Diagram of the Junkbox Phone (No. 2) Legend & List of Parts Required

L1, L2 and L3 all identical. For 160 Meters should be 45 turns on 2½-in. form, space wound.
L4—Depends on antenna type.
T1—Mike Transformer.
T2—Any good grade audio Transformer.
CH—Center-tapped 180 MA Choke, 30 to 60 Henries.
MA—0-150 MA Milliammeter.
R1—50,000 ohms.
R2—Volume control, 200,000 ohms.
R3—2500 ohms.
R4—100 ohms.
R5—30,000 ohms.
R6—15,000 ohms.
R7—5,000 ohms.
C1—.01 mfd.
C2—.5 to 2 mfd.
C3—.00015 to .00035 Variable.
C4—.000025 Variable (Neutralizing).
J1, J2, J3, J4, J5—Meter Jacks.

Important!

Some notes on the practical use of the table shown on the facing page appear in the column below

↓ ↓ ↓ ↓

Audio Power That Can Be Obtained From the More Common Modulator Tubes

INFORMATION about the amount of audio power which any given tube can supply at a given plate voltage is rarely obtainable when needed. In the first place, most amateurs operate their tubes at higher plate voltages than recommended by the tube manufacturers, and they are also handicapped by the newness of class B and class A prime circuits. On the facing page I present a table showing the amount of audio power obtainable from most of the common tubes at most of the usual plate voltages. Note that in all cases where but one tube is shown in a class A circuit, it is possible to put two or three tubes in parallel to obtain two or three times the audio output. For example, in the 750 volt section of the table we see that one 845 will deliver 10 watts of power. Therefore, three 845's in parallel will deliver 30 watts. However, if more than three tubes of a given type are connected in parallel we must reduce the output, bcause of parasitics and harmonic distortion.

The first column shows the audio output in watts, the next shows the number, type and circuit connection. (Push-pull or otherwise). The next column shows whether the given tube is to operate in class AA prime, or class B. Next we have the best driver tube. It is not essential that the exact driver shown be used, but any other tube substituted must supply an equal amount of grid voltage or grid power, as the case may be.

The last column shows the method of coupling the tube to the load. For 100% modulation, the DC plate input to the class C modulated RF amplifier should be slightly less than twice the audio output of the modulator tubes. In other words, the modulators must supply audio power equivalent to from 55% to 60% of the DC input to the class C modulated stage. Theoretically, only 50% is necessary, but due to losses in coupling, etc., it is necessary to have a reserve of audio power to avoid that type of distortion known as "carrier shift."

It should be noted that each modulator tube must work into its proper load impedance if full output is to be obtained without excessive distortion. If the load is coupled to the modulator tube by means of a choke and condenser, it is essential that the plate milliamperes and plate volts of the modulated amplifier be adjusted until they represent the proper load for the modulators. If transformer coupling is used between the modulators and class C amplifier, the load resistance also must be adjusted to the optimum value for the tubes and specific transformer used. Once you have decided on a particular modulator circuit and tube type, learn from a tube table, or from the tube manufacturer, the proper load resistance for the plate voltage you intend using. Transformer manufacturers who specialize in audio equipment are always glad to provide exact information on their equipment, and often know more about the proper load impedance for a given tube under given conditions, than does the tube manufacturer.

Voltage ratings on some of the tube combinations shown cannot be considered conservative. While all of the combinations are entirely practical for voice work, some of the voltages represent the absolute maximum.

A Ribbon Mike Amplifier

THE power output of a ribbon mike (also dynamic and condenser mike) is only about one-ten-thousandth of the output of a high quality two-button carbon mike. Thus we need some form of preamplifier between the mike and the usual speech amplifier. A power gain of 10,000 equals 40 decibels, and some leeway should be allowed for losses in transmission lines and coupling. Therefore, the amplifier shown in Fig. 2 shows a gain of about 50 DB, and will yet be quite stable and free from feedback if some of the usual precautions are taken in regard to shielding and isolation. It is important that this pre-amplifier be separated at least three feet from any power transformers so as to avoid inductive pickup by the mike coupling transformer. The entire amplifier should be mounted in some form of shield can to keep RF from upsetting things. The tubes should be individually shielded and the grid lead to the screen-grid tube should also be shielded. R3 is a volume control but a fixed resistor would do just as well.

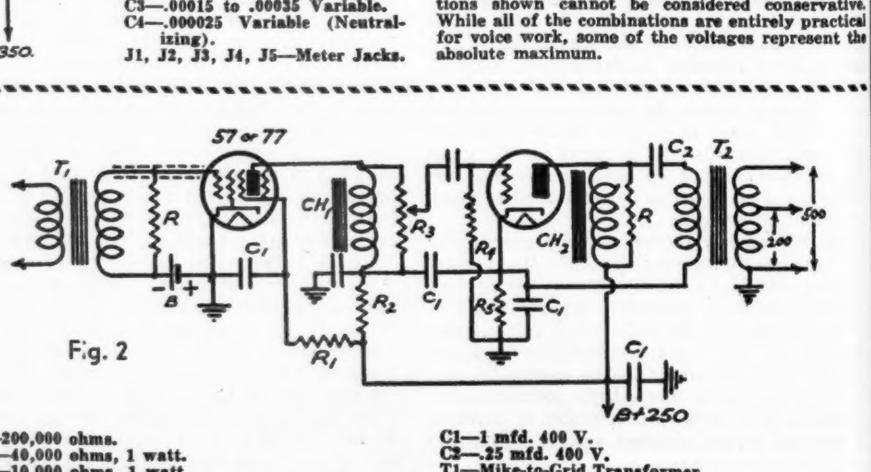


Fig. 2

R—200,000 ohms.
R1—40,000 ohms, 1 watt.
R2—10,000 ohms, 1 watt.
R3—250,000 ohms, Lograthmic Tapered Potentiometer.
R4—1 megohm.
R5—2,500 ohms.
C1—1 mfd. 400 V.
C2—.25 mfd. 400 V.
T1—Mike-to-Grid Transformer.
T2—Tube-to-Line Transformer.
CH1—400 to 800 henries, 5 MA.
CH2—100 henries, 10 MA.
B—1½ volt flashlight battery.

Table Showing Audio Output of Modulator Tubes

Plate Volts	Audio Power	Type of Tube	Class	Driver Tube	Coupling to Load
PLATE VOLTS 400	4 watts	1—250	A	56, 27, 12A, etc.	Choke and Condenser
	25 W.	2—46's or 59's or 53's. PP.	B	PP 45's	Transformer
	40 W.	4—46's in push-pull Par.	B	PP 2A3's	Transformer
PLATE VOLTS 450	4.6 W.	1—250	A	56 or equiv.	Choke and Condenser
	15 W.	2—250's in push-pull	A	56 or equiv.	Transformer
	30 W.	2—46's, etc., push-pull	B	PP 45's	Transformer
	50 W.	4—46's, etc., push-pull Par.	B	PP 2A3's	Transformer
PLATE VOLTS 500	5 W.	1—250	A	56 or equiv.	Choke and Condenser
	7.5 W.	1—845 or WE284A	A	210 or 45	Choke and Condenser
	35 W.	2—210's or 841's. PP.	B	PP 45's	Transformer
PLATE VOLTS 600	4.5 W.	1—WE211D or E	A	210 or 45	Choke and Condenser
	8 W.	1—845 or WE284A	A	210 or 45	Choke and Condenser
	30 W.	2—250's. PP.	A PRIME	45 or 250	Transformer
	40 W.	2—210's or 841's. PP.	B	PP 45's	Transformer
PLATE VOLTS 750	5.5 W.	1—RK18 or WE211E	A	56 or equiv.	Choke and Condenser
	6.25 W.	1—211 or WE242A	A	56 or equiv.	Choke and Condenser
	7.5 W.	1—830	A	210 or 45	Choke and Condenser
	10 W.	1—845	A	210 or 45	Choke and Condenser
	15 W.	1—WE284A	A	210 or 45	Choke and Condenser
	50 W.	2—210's or 841's. PP.	B	PP 2A3's	Transformer
	70 W.	2—RK18's in push-pull	B	PP 2A3's	Transformer
	75 W.	2—WE211D or E, push-pull	B	PP 2A3's	Transformer
	90 W.	2—800's, push-pull	B	PP 2A3's	Transformer
PLATE VOLTS 1000	8.5 W.	1—RK18	A	56 or equiv.	Choke and Condenser
	10 W.	1—HK354	A	210 or 45	Choke and Condenser
	10 W.	1—211 or WE242A	A	210 or 45	Choke and Condenser
	15 W.	1—845	A	210 or 45	Choke and Condenser
	25 W.	1—WE284A	A	210 or 45	Choke and Condenser
	40 W.	2—830's in push-pull	A PRIME	PP 45's	Transformer
	75 W.	2—845's in push-pull	A PRIME	PP 45's	Transformer
	100 W.	2—800's, push-pull	B	PP 2A3's	Transformer
	100 W.	2—WE284A's, push-pull	A PRIME	PP 2A3's	Transformer
	100 W.	2—WE211D or E, push-pull	B	PP 2A3's	Transformer
	140 W.	2—211's or WE242A. PP.	B	PP 2A3's	Transformer
	170 W.	2—HK354's in push-pull	B	PP 2A3's	Transformer
	200 W.	2—203A's in push-pull	B	PP 2A3's	Transformer
PLATE VOLTS 1250	12 W.	1—211 or WE242A	A	210 or 250	Choke and Condenser
	20 W.	1—845	A	210 or 250	Choke and Condenser
	30 W.	1—WE284A	A	210 or 250	Choke and Condenser
	90 W.	2—845's in push-pull	A PRIME	PP 2A3's	Transformer
	106 W.	2—800's in push-pull	B	PP 2A3's	Transformer
	125 W.	2—WE284A's in PP.	A PRIME	PP 2A3's	Transformer
	170 W.	2—211's or WE242A's. PP.	B	PP 2A3's	Transformer
	195 W.	2—HK354's, in P.P.	B	PP 2A3's	Transformer
	225 W.	2—203A's, push-pull	B	PP 250's	Transformer
	400 W.	4—203A's-push-pull parallel	B	PP 250's	Transformer
PLATE VOLTS 1500	35 W.	1—WE212D	A	210 or 250	Choke or Transformer
	75 W.	1—HK255	A	203A or 211	Choke or Transformer
	130 W.	2—845's, push-pull	A PRIME	PP 2A3's	Transformer
	145 W.	2—WE284-A's, PP.	A PRIME	PP 2A3's	Transformer
	225 W.	2—HK354's, push-pull	B	PP 2A3's	Transformer
	350 W.	2—WE212D's in push-pull	B	PP 250's	Transformer
	400 W.	2—HK255's in push-pull	A PRIME	PP 210's or 250's	Transformer
PLATE VOLTS 1750	87.5 W.	1—HK255	A	203A or 211	Choke or Transformer
	265 W.	2—HK354's, push-pull	B	PP 250's	Transformer
	400 W.	2—WE212D's in push-pull	B	PP 845 or equal	Transformer
	500 W.	2—HK255's in push-pull	A PRIME	PP 211 or equal	Transformer
PLATE VOLTS 2000	20 W.	1—HK354	A	210 or 45	Choke and Condenser
	40 W.	1—204A*	A	210 or 45	Choke and Condenser
	50 W.	2—HK354's, push-pull	A	210 or 45	Transformer
	60 W.	1—849*	A	210 or 45	Choke and Condenser
	100 W.	1—851*	A	210 or 45	Choke and Condenser
	100 W.	1—HK255	A	203A or 211	Choke or Transformer
	300 W.	2—HK354's, push-pull	B	PP 250's	Transformer
	400 W.	2—204A's in push-pull	B	PP 845 or equal	Transformer
	500 W.	2—849's in push-pull	B	PP 845 or equal	Transformer
	600 W.	2—HK255's in push-pull	A PRIME	PP 211 or equal	Transformer
PLATE VOLTS 2500	500 W.	2—204A's in push-pull	B	PP 845 or equal	Transformer
	600 W.	2—849's in push-pull	B	PP 845 or equal	Transformer
	750 W.	2—HK255's in push-pull	A PRIME	PP 211 or equal	Transformer
	750 W.	2—WE270A's, push-pull	B	PP 845 or equal	Transformer

* NOTE THAT THESE TUBES ARE NOT SUITED FOR CLASS A USE, 204A, 849 AND 851.

I. C. W.?

By WM. H. McAULAY (W6KM)

SINCE October 1933 most good hams take great pride in their "pure DC" notes. The mere suggestion of using ICW, officially known as type A 2 emission, in the most-used amateur bands is likely to class the suggester with the old die-hards who held out valiantly for spark in the days when there were real arguments over which was best . . . spark or CW. The case against ICW notes is not nearly so strong as was the case against spark in those days.

The objection to ICW notes in the past has been the fact that ICW as it was used caused interference over a wider band of frequencies than unmodulated notes of comparable power. The very great advantages of using ICW are: first, if some signals are modulated we are giving them a distinctive characteristic which permits them to be separated from other signals in the overcrowded bands, and second, modulated notes are relatively free from that type of fading known as selective fading, which at times is very bad in the high-frequency bands for pure DC signals and is the type of fading which causes fone signals to mush up and become unintelligible even on the low frequency broadcast channels. It can be shown that the effective interference created by a "good" ICW note in any given receiver will be no greater than that created by a pure DC note of the same power for average signal strengths. How good an ICW note is depends on the purity of the modulating tone, the percentage by which the carrier is modulated, the frequency of the modulating tone, and most important of all the stability of the carrier frequency. The measure of interference is the amount of disturbance an unwanted signal causes in a receiver tuned to some other signal. The interference does not necessarily depend on the width of band that the modulated signal occupies, provided the modulating tone is in the lower audio range, say 500 cycles per second or less.

The proponents of pure DC signals are overlooking the possibilities of the most useful single signal filter known for the ham receiver, and that filter is the combination of the operator's ear and mind. For that filter to operate successfully, each signal that is audible at any one time must have some distinguishing characteristic or else the operator will have difficulty in telling which is the one he wants to copy. The distinguishing characteristic may be the loudness, the speed of the sending, the sender's characteristic fist, the modulation of an ICW note, or the lack of modulation if it is a pure DC note. It is not just a possibility, but an actual probability that while copying a weak signal in any of the present crowded bands, the operator will be confused by hearing from one to four or more signals right on top of the one which he is trying to copy. These signals may all be of about the same strength, and if all are "adequately filtered DC" he may have no choice but to wait until the QRM subsides. In most cases, providing the wanted signal is not overridden by much stronger signals, a slight difference in the character of the wanted signal would make a QSO possible. At present this slight difference in signals is mainly due to some signals being pure DC, while others not quite so well filtered are "near DC" with 120 cycle ripple. This excludes the other possibilities such as chirpy, wobbly, or buzz-saw notes which may still be heard, and leaves us with about two types of notes to chose from, pure DC, or nearly DC with 120 cycle ripple. How much better it would be if we could modulate some of those signals with audio tones of up to four or five hundred cycles per second and still not add to the already-terrific QRM!

The single signal receiver is a great help in separating signals if they are even only a few cycles apart, but even this receiver fails when the signals are right on the same frequency. For the present at least, and probably in the future, the single signal receiver is, and will be, a luxury which the average amateur cannot afford, and for this reason can hardly be set up as the standard of selectivity among ham receivers.

In Fig. 1 is shown the selectivity curve of a modern superheterodyne receiver suitable for the reception of either fone or CW signals. It is not as selective as the single signal receiver, a selectivity curve of which is shown in Fig. 2, but is much sharper than the average ham receiver which we might define as a tuned RF set using a regenerative detector and one stage of tuned RF amplification. In Fig. 1, (A) represents an ICW signal which is just on the threshold of being audible. This ICW signal is shown with its carrier in the center and a sideband on either side of the carrier. For a signal modulated 100 per cent, the sidebands will be weaker by 6 DB than the carrier. If the signal were modulated only 50 per cent, then the sidebands would be weaker than the carrier by about 12 DB. Since the slope of the receivers' selectivity curve is not at all vertical, it is seen that as the receiver is tuned into this modulated signal the carrier is audible at the same time and on the same point on the dial as the first sideband. In other words, if the receiver is tuned to the pure DC signal, (B), and the ICW signal starts up, the sideband interference from (A) is no greater than the carrier interference from (A), and if (A) were a pure DC signal with the same carrier amplitude as it now has, the interference with (B) would be just as great as the ICW interference. Now suppose that (A) and (B) are very close together and that (B) is of the same strength as the carrier of (A). (A) is modulated and has sidebands, (B) is unmodulated but due to the difference in the characters of the notes it will be easy for a good operator to copy either one or the other, which he could not do if both signals sounded exactly the same.

From Fig. 1 it is seen that a modulation tone of about 500 cycles per second is allowable without increasing the interference. If we take into consideration the fact that this receiver has a sharper selectivity curve than the average ham receiver, it will be seen that modulation tones of up to about 500 cycles per second should not be unreasonable. If modulation tones higher than 500 cycles per second are used it is seen from (C) of Fig. 1 that our superheterodyne receiver would pick up the first sideband before the carrier is audible, and so the signal could be called broad for this particular set.

The selectivity curve of a good single signal receiver is shown in Fig. 2. This receiver uses a quartz filter in the intermediate frequency amplifier and is about the sharpest practical set that could be built. Its selectivity curve is quite steep compared to other receiver curves, but even it is not vertical at the steepest point and (E) of Fig. 2 shows that a signal modulated 100 per cent by a tone of 150 cycles per second will cause no more interference than an unmodulated signal of the same strength as the carrier of (E). If the modulation is reduced to 50 per cent, (J) of

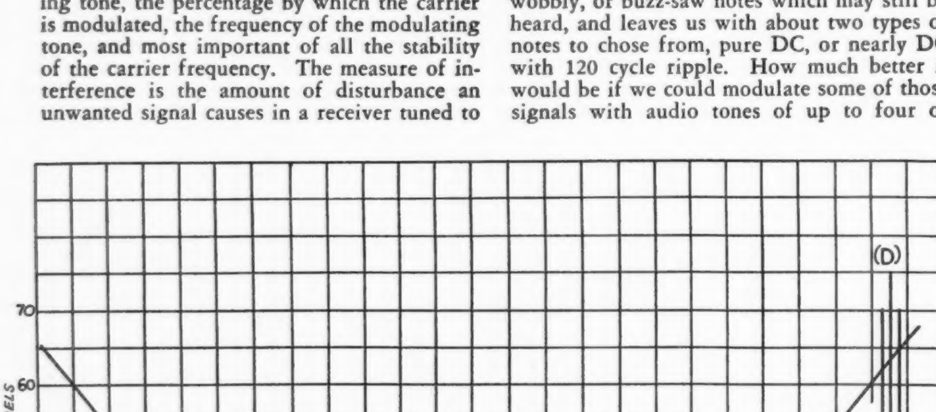


FIG. 1

Fig. 2 shows that a modulating frequency of about 300 cycles per second is allowable, even if this extremely sharp receiver were to be taken as a standard.

From the foregoing we can see that the amount of interference caused by a good modulated note in a given receiver depends on the slope of the selectivity curve of that receiver. If we were to take the slope of our superheterodyne receiver of Fig. 1 as an average of ham receivers, then modulations of up to 500 cycles per second should not be unreasonable, and even higher modulating tones might be used if the percentage of modulation is reduced. For reasons to be shown later, it would probably be best not to use tones much higher than 500 cycles per second, regardless of how low the percentage of modulation.

Selective fading is caused mainly by the signal arriving at the receiving point by two or more shifting paths. As the paths vary in distance, due to variations in the reflecting medium, a complicated interference pattern is set up about the receiving antenna. At times the different portions of the signal arrive out of phase, causing a drop in the received signal strength. Often the signal may be arriving by two paths with about the same strength. When these two equal components shift out of phase the signal in the receiver drops to nothing. This type of fading is more easily identified in fone reception than in CW reception. With fone signals, this type of fading may not make a great deal of difference in the loudness of the signal, but every so often the voice or program will simply be garbled into a meaningless hash. This garbling occurs whenever the carrier is weakened or canceled out entirely by two nearly equal components arriving out of phase, but the sidebands or most of them will still be coming through. As long as the carrier is strong, a few sidebands may be canceled out and cause only a little distortion, but the carrier must be there, else the fone signal will be unintelligible. To get back to CW and ICW, an unmodulated signal consisting of only one frequency is at a great disadvantage when selective fading is taking place. During the periods of partial cancellation the signal is weak and it goes out completely with total cancellation of the two wave paths. An ICW signal consists of a carrier and two sidebands differing in frequency from the carrier by the modulation frequency. In copying a telegraph signal we do not need the carrier as well as the sidebands, as in fone reception. If only one of the sidebands is coming through we may still copy the signal, and it is very improbable that the carrier and both sidebands will be canceled out at the same time. This is true even of a signal modulated by a very low tone, as a little arithmetic will show. Take for example a signal in the 7000 KC band modulated by a 60-cycle per-second tone. If the carrier frequency is 7,100,000 cycles per second, the higher sideband will have a frequency of 7,100,060 cycles and the lower sideband will have a frequency of 7,099,940 cycles per second. The two sidebands differ from the carrier by a small fraction of a wavelength, about .000,005 meters. In about 110,000 wavelengths, or 2,700 miles, the higher frequency sideband will gain one complete cycle over the carrier and the lower frequency sideband will have one less cycle than the carrier, and all three will be in about the same phase relation to each other as when the signal started. If the signal is arriving at the receiver by two paths with equal strength, complete cancellation of the carrier will result whenever the paths differ in length by an odd number of half wavelengths of the carrier. If the two paths differ in distance by only a few half wavelengths, or if the difference in distance is roughly 2,700 miles, then the phase relations of sidebands to carrier will be such that the sidebands are nearly canceled out at the same time that the carrier is canceled out. However for intermediate differences of path length the sidebands do not cancel out at the same time the carrier is canceled. If the path lengths differ by about 1350 miles, the sidebands will add respectively and double in strength at the times when the carrier is canceled out. Remember that between these limits there are about 100,000 odd half wavelengths, and every time the two path lengths differ by an odd number of half wavelengths the carrier goes out. The point we are trying to make is that even though a low modulating tone is used, and selective fadeing is so bad that single frequencies disappear several times in a minute, still only on rare occasions will the carrier and two sidebands fade at any one instant. The commercial communication companies in many cases use modulated notes on their transmitters when it is not practical to use diversified reception of the signals by two or more receivers with antennas separated a few hundred feet. Obviously, diversified reception is not practical for marine work and it is here that these companies make the greatest use of modulated notes.

There is one place where modulated notes would give trouble and we should examine this case to see just how serious this might be. In Fig. 1 (D) represents a very strong local signal which will be heard even though several kilocycles removed from the desired signal. If this signal were pure DC and had no key thumps, its beat note beating with our oscillating detector would be quite high in frequency and therefore would not interfere. If this signal is modulated, its beat notes will still be quite high but the beat note between carrier and sidebands will be audible and interference will result locally. There are several answers to this objection. First, since we have agreed to keep our modulating frequency low, 500 cycles or lower, it would be an easy matter to equip receivers with a variable tone control capable of cutting-out frequencies of below, say, 800 cycles per second. Also the response curve of the human ear reaches its maximum at about 2000 cycles per second and falls off below that frequency. Due to this characteristic of the ear, beat notes of between 1000 and 2000 cycles are used by most operators. An interfering 500 cycle tone would have to be 10 DB stronger than the wanted signal which is given a beat note of about 2000 cycles per second, for it to be as noticeable to the operator's ear as the wanted signal. If the modulating tone is 60 cycles per second it will have to be 48 DB above the wanted signal, the beat note of which which is 2000 cycles, to be as noticeable to the operator. 48 DB represents a difference of power of 16,000 to 1! The ear response curve is taken from K. S. Johnson's "Transmission Circuits for Telephone Communication". Second, even a pure DC signal with a good thump filter has some key thump effect and will cause interference locally. Third, modulation might be restricted to very low tones and percentages in congested districts, this would correspond to present-day signals of the "near DC" variety which seem to be not objectionable, provided there is no frequency modulation.

The equipment to modulate a transmitter with pure tones would be more complicated than the old and simple self-rectifying outfits. The plate supply would still have to be adequately filtered and the modulation superimposed on the DC plate supply by a separate transformer, or any of the systems used in high-quality voice transmission for modulating the amplifier could be used. Of course, the frequency control would have to be the equivalent of crystal control.

It is beyond the scope of this article to go into practical detail since under our present FRC amateur regulations type A 2 emissions are not to be used in the lower-frequency bands. It is believed that if enough interest in modulated notes is shown by a large group of amateurs the FRC could be induced to modify this rule so that ICW might be used intelligently in all bands.

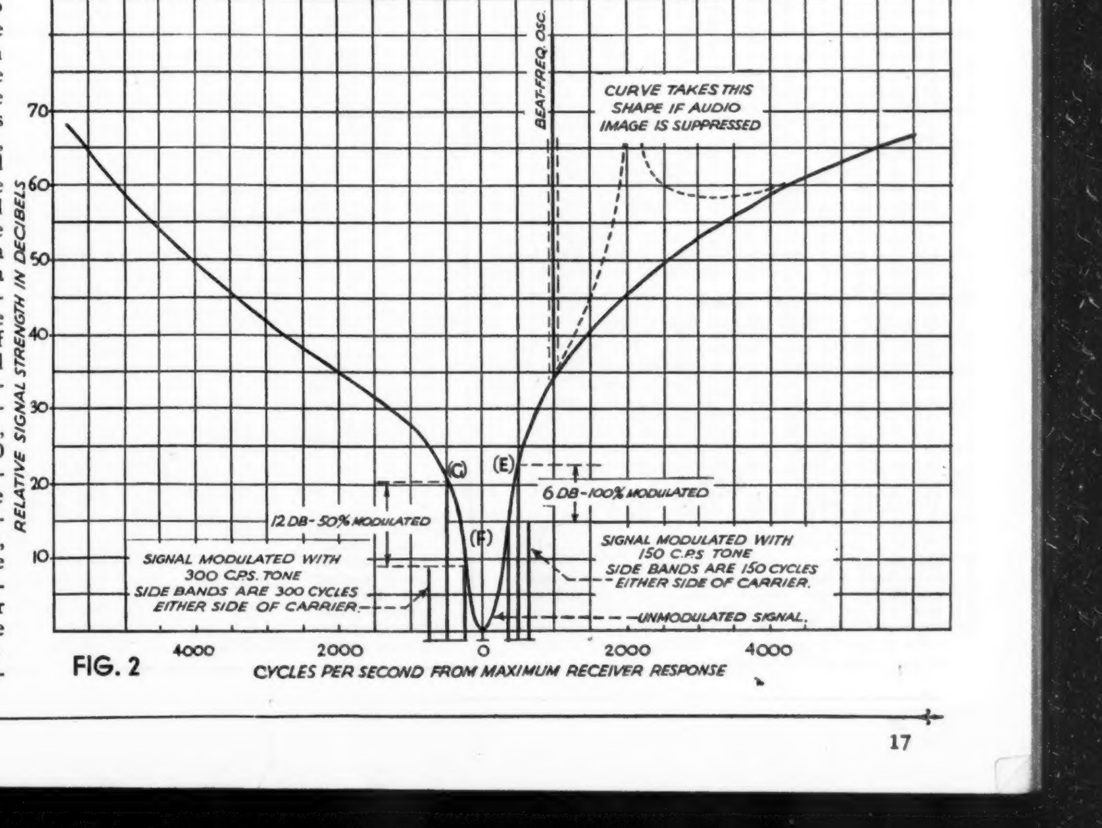


FIG. 2

Tube Technique

By "JAYENAY"

Gammatron in Grounded-Grid Circuit

FIG. 1 shows a circuit of the grounded-grid type for use with the new Heintz & Kaufman Type 354 Gammatron. When this circuit is used it is not necessary to neutralize, because the input circuit is shielded from the output circuit by the grid. Thus a rapid change in frequency can be made. The plate-to-filament capacity of the 354 Gammatron is negligible, and therefore its use is permissable in the circuit shown. However, this circuit also has

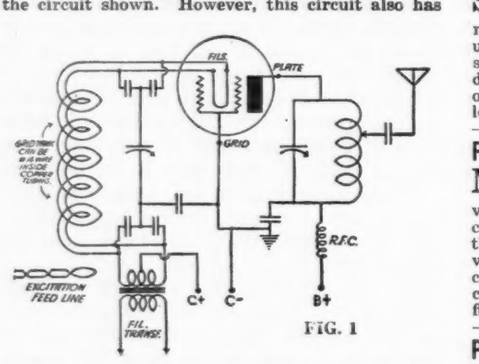


FIG. 1

its disadvantages. The DC plate return to the filament must go through the grid coil, which has a tendency to cancel out the grid excitation, making the amplifier somewhat harder to excite than a conventional neutralized triode amplifier. This condition can be remedied by feeding back energy from the plate to the filament by means of a condenser, and thus by the introduction of a slight amount of regeneration in the circuit, this detrimental effect is overcome.

The FB 126

FOR those interested in generating waves below one meter in length, we suggest the General Electric FB 126 as an oscillator. This tube is especially designed to operate as a NON-REGENERATIVE oscillator. This system of oscillation is known by a wide variety of names, thus, Barkhausen-Kurz, Kozanowski, Gill-Morrell and, more strictly, "Electron orbit oscillation". The tuned circuits usually consist of Lecher wires and the tube usually operates with a positive grid and negative plate voltage. This tube gives good results down around 50 CM. (600,000 KC to you). The envelope is about 8 inches long and is made of special glass.

Thyratron

THYRATRON is the trade name that General Electric uses to describe their grid-controlled mercury vapor relays. These mercury vapor relays also are used as rectifiers and much resemble conventional mercury vapor rectifiers, such as the 866 and 872. An ordinary control grid is located between the anode and cathode and acts in much the same way as the control grid in ordinary vacuum tubes. However, this control grid can only start the flow of current. It must be stopped from an outside point because it cannot cut-off the plate current once it has started to flow. When these tubes are used as rectifiers, the flow of current is automatically cut off once each cycle, so while the grid cannot stop the flow, it can prevent it from starting on the next positive half cycle. These grid rectifiers are finding thousands of applications in various industries and are FB for keying a tube transmitter. They draw practically no grid current and thus a very small controlling voltage can control many kilowatts of power. Some of these tubes are designed for a positive grid bias, others use a negative grid bias to prevent the current flow.

The RK 19 Full Wave Rectifier

RAYTHEON has announced a full wave, high vacuum rectifier which will deliver 175 milliamperes at 1000 volts DC. It looks good. The plate leads are brought out of the top of the envelope. It is somewhat like an overgrown 5Z3. It will take care of a 50-watter running close to full output, and will supply any two of the new 40-watters, such as the RK18, RCA 800, Sylvania 825 and 830.

The 2A5 and 42 In Class A Prime

THE 42 and the 2A5 do well in class A prime circuits and a pair of either tubes will deliver about 8 watts with cathode bias, and about 11 watts with fixed bias. (The 42 and the 2A5 are identical except for their heater voltages. 42 is 6.3 volts and the 2A5 is 2.5 volts). The screen grid is connected to the plate at the socket. About 50 volts of bias is necessary. Philco uses this system in new high-priced receivers.

Using the 46 As a Screen Grid Tube

SEVERAL hams have used the 46 with about 150 volts positive on grid number two with grid number one (which is grid closest to filament) used as the control grid. They claim greater power sensitivity, both as a straight amplifier and as a doubler. It might be worth trying as a crystal oscillator, although the output would probably be less than if the usual pentode were used.

Filament Voltmeters

MOST hams realize the advisability of maintaining the filaments of transmitting tubes at rated voltage. This is of especial importance in the case of mercury vapor rectifiers. It behooves me, therefore, to point out that usual AC low-range voltmeters can have an error of nearly 20%, so check your voltmeter occasionally against an accurate standard. If in doubt, it pays to keep the filament voltages slightly **higher** than rated.

Pentodes As Crystal Oscillators

I HAVE received many inquiries as to the BEST tube to use as a crystal oscillator. ALL the pentodes are approximately equal in this respect when used at 250 volts or below. For use at higher voltages I prefer the 2A5, 47 or 42 because these tubes have slightly more cathode emission. It has been determined that the 89 and the 38 are most desirable for use with a 14 MC crystal (Quartz or Tourmaline) but the power output is rather low. The best way to get the most power out of a crystal oscillator is to use "link coupling" between the crystal plate tank and the next stage. Other methods of coupling tend to make the crystal stop oscillating before maximum output is reached. This, undoubtedly, is tied-up with the solemn mysteries of impedance matching.

The Infinite Variety of Class C Amplifiers

ANY vacuum tube amplifier whose bias exceeds the cut-off value is included in the general classification of a class C amplifier. The technical staff of "RADIO" has decided that in the future it will more closely define what is meant by "Class C" by adding a figure to the class C designation of an amplifier, which figure will be arrived at by dividing the total bias by that amount of bias known as "cut-off." Thus a tube biased to three times cut-off will be described as "Class C3." If the total bias equaled two-and-seven-tenths times cut-off, the amplifier will be described as "Class C2.7."

RF Grid Current

ALL manufacturers of transmitting tubes place a limit on the RF grid and plate current which their tubes will stand. This rating has puzzled some hams because it usually deals with 5 or more amperes. This limit refers to the current which circulates through the tube, due to its inter-electrode capacity. It is evident that the plate and filament acts as a small condenser and this condenser is in shunt with the plate tank. Thus part of the tank current circulates through the plate and filament leads. Likewise, the grid-to-filament capacity is in shunt with either a grid tank or the plate tank of the preceding stage. Therefore, the leads to the tube elements are apt to heat and burn out if this circulating current reaches a high value. This current has nothing to do with the normal space current flowing through the tube, because this current will circulate even when the plate and filament voltages are removed.

As the frequency is raised, this flow of current increases. It is also high in those tubes with a high interelectrode capacity to ground, such as the 211, 203A, 210, 204A, 849, 851 and practically all of the screen grid tubes.

One advantage of the newer high-frequency tubes, such as the 852, 800, 354, 825 and RK18, is that they may be used up around 60,000 KC without special precautions being taken to reduce this circulating current.

TRANSMITTING TUBE TABLE

	HK354	211-242A	203A	800	852	204A	F108A
Filament Volts	5 Volts	10 Volts	10 Volts	7.5 Volts	10 Volts	11 Volts	10 Volts
Filament Amperes	7.75 Amps	3.25 Amps	3.25 Amps	3.25 Amps	3.25 Amps	3.85 Amps	11 Amps
Peak Fil. Emission	4.00 Amps	3.25 Amps	3.25 Amps	2.45 Amps	3.25 Amps	4.2 Amps	3.65 Amps
Plate Dissipation	100 Watts	100 Watts	100 Watts	35 Watts	100 Watts	200 Watts	175 Watts
Interelectrode Capacities							
Plate to Grid	3.7 MMF	15 MMF	15 MMF	2.5 MMF	3 MMF	17 MMF	7 MMF
Grid to Filament	9 MMF	8 MMF	8 MMF	2.75 MMF	2 MMF	18 MMF	3 MMF
Plate to Filament	Less than 4 MMF	7 MMF	7 MMF	1 MMF	1 MMF	3 MMF	2 MMF
Amplification Factor	12	12 -	25	15	12	24	12
Plate Resistance (at zero bias)							
Plate Volts 1000	2750 ohms	1900 ohms	5000 ohms	6800 ohms	—	—	9000 ohms
Plate Volts 2000	2000 ohms	—	—	—	6000 ohms	4700 ohms	8000 ohms
Mutual Conductance							
Plate Volts 1000	5800 MMHOS	6300 MMHOS	5200 MMHOS	2300 MMHOS	—	—	1330 MMHOS
Plate Volts 2000	6900 MMHOS	—	—	—	2000 MMHOS	5100 MMHOS	1500 MMHOS

RECOMMENDED TUBE OPERATING CONSTANTS

OPERATION AT 1000 VOLTS

	HK354	211-242A	203A	800
Class B (Linear) Amplifier				
Negative Bias	—75 Volts	—75 Volts	—35 Volts	—60 Volts
Plate Current	130 MA	130 MA	130 MA	45 MA
Carrier Output	40 Watts	40 Watts	40 Watts	14 Watts
Class C amplifier				
Negative Bias	—200 Volts	—200 Volts	—100 Volts	—180 Volts
Plate Current	175 MA	175 MA	175 MA	105 MA
Normal Output (Eff. 66%)	116 Watts	116 Watts	116 Watts	70 Watts

OPERATION AT 2000 VOLTS

	HK354	852	F108A	204A
Class B (Linear) Amplifier				
Negative Bias	—200 Volts	—150 Volts	—150 Volts	—70 Volts
Plate Current	65 MA	65 MA	115 MA	130 MA
Carrier Output	40 Watts	40 Watts	70 Watts	80 Watts
Class C Amplifier				
Negative Bias	—375 Volts	—375 Volts	—375 Volts	—175 Volts
Plate Current	150 MA	100 MA	150 MA	200 MA
Normal Output (Eff. 66%)	200 Watts	133 Watts	200 Watts	266 Watts

Some Thoughts on Reducing Noise Level and Increasing Distance Range

By E. M. SARGENT

IN RECENT years amateurs, radio fans and experimenters generally have adopted a resigned attitude towards noise level, and to a somewhat surprising degree have come to regard it as a curse of a given location which it is beyond their power to change. There is common acceptance of the fact that every location has a certain "noise level" of its own and that DX signals must come through with a greater field strength than this in order to be heard, all weaker ones being irretrievably lost. The writer, along with everyone else has subscribed to this idea in times past, but recently while speculating over the results of some twenty-odd years of struggling to get DX has recalled some experiments which lead to seriously questioning it. In fact, the writer is now convinced that the entire idea is a fallacy, and that we have been entirely too passive in accepting a noisy location as such. There is, of course, no method by which we can make a noisy, downtown location the equal of a quiet country one, but there is a great deal that we can do, that we are not now doing, to improve both.

For a number of years old timers have been puzzled by the fact that the distance range of receiving sets has apparently not kept pace with improvements in the industry. This statement does not include results obtained on the short waves because ten or twenty years ago these were unknown. On the wavelengths that have been in use for all of this time, 200 meters and up, there has been **no increase whatever** in receiving range. In 1913 the Navy station NPH at Mare Island, California, used to work occasional schedules with NAR, Key West, Florida, and once in a while with NAA at Washington, D. C. This was with spark transmitter and with crystal receiving sets at both ends. Spark sets are now obsolete, but with the C.W. transmitters of much better carrying power now in use, it is doubtful if these schedules could be duplicated on the same wavelengths except with great difficulty, even with vacuum tube receiving sets. Possibly there has been some change in the ether itself which has been consistently reducing receiving range. We have no way of checking this so cannot tell, but there are other factors much more under our control which have changed and which are more likely to be responsible. Our present day receivers use enough tubes to light a Christmas tree and yet come out of it all with a receiving range not as good as was common with one tube 15 years ago. Maybe the low price of tubes is responsible. If so, be assured it was not always thus! The writer can well remember in the dim past when we amateurs were asked to buy $18.00 worth of junk rheostats and tap switches in a pine box in order to be allowed to purchase just one (1) of the three element vacuum tubes of that day. Which brings to mind the raid on the DeForest exhibit booth at the Panama Pacific Exposition—but that's another story. Needless to say we did not go in much for amplifiers, and when we did lay hold of one of those tubes we got everything out of it that there was to get.

At the present time we are paying too much attention to amplification in our receivers, with too little regard to sensitivity. Our signals on stations 1000 miles away are a thing of beauty, and for the B.C.L.'s in the broadcast band they serve a most useful purpose, but to a DX fan a station 1000 miles away is not even worth logging. However, because of the commercial exploitation in the broadcast band, engineering effort has been directed particularly to its needs, and the amateurs have unconsciously followed without realizing perhaps that their own requirements for extreme DX reception were entirely different.

When there was less amplification available it was necessary to devote much more attention to sensitivity, and when even sensitivity was limited, as in the case of the crystal receiving sets, the only way to get distance was by devising the best possible antenna and ground. Therein lies the secret—the difference between the receiving range of 15 years ago and that of today. The antenna and ground system is the energy pickup—the basket, if you will, that catches the waves and dumps them at the input of the receiver. And if the basket doesn't catch them it doesn't make much difference what kind of a receiver is used behind it. All the amplification in the world will not bring them back if they do not reach the receiver input with enough energy to actuate the first tube. We have for years been reducing the pickup of our antenna systems and trying to make up the difference with more tubes, and it cannot be done. We can take down the large antenna and duplicate the signal strength of a station 1000 miles away with six feet of wire for a pickup, but with more noise and with a great decrease in receiving range.

In a discussion of noise level it will be assumed for the purpose of this article that everything has been done to keep the noise level of the receiver itself at an absolute minimum. Perhaps in a later article this subject will be taken up, but we are interested here in noise which is picked up outside of the receiver. An important point to bear in mind, and one not generally known, is that the amplitude of the waves that go to make up the noise level is much greater than that of a signal which will have an equal headphone or loudspeaker volume. With some types of noise interference the wave amplitude must be high enough to swing the detector grid positive to make the interference audible. Under such conditions the waves from the noise interference build up through the r.f. amplifier almost to the limits of the tubes, and hence any increase in the input energy of these waves would **not** result in a corresponding increase of output. Another factor of importance is this. With a DX signal, from a distance of 1500 miles or more, the field strength varies almost directly as the distance, but with waves from a source of nearby power interference the field strength varies as the square of the distance. This results in the field of power interference being highly concentrated and it attenuates rapidly in all directions. A source of power interference near the lead-in might not affect the flat top portion of the antenna greatly, and if the length of the flat top were doubled the result might easily be to double the strength of the desired signal with practically no increase in noise level. Of necessity the lead-in runs nearer to power wires than the flat top portion of the antenna. The pickup effect of the lead-in can be almost entirely neutralized by using a doublet type antenna and transposing the lead-in every few inches. Shielding of the lead-in has been tried also, but this always results in loss at the shorter wavelengths, and shielded lead-ins are almost worthless for work on 40 and 20 meters. If the shield could be made a foot or two in diameter and non-magnetic it would probably be satisfactory, but in most cases this is impractical.

The answer would appear to be in increasing the height of the antenna and particularly in lengthening the flat top portion to such an extent that the energy pickup of the desired signal would be boosted enough to raise it above the noise level. Length is more important than height providing the height is at least 40 feet. The effective length of an antenna is its longest dimension in a straight line, not the total number of feet of wire used. Thus, to zigzag the wire back and forth, or to spiral it does not increase the real antenna length and merely results in added resistance and waste of wire.

An antenna of the largest possible dimensions is to be desired, but equal attention should be paid to the materials that go into its construction. Almost any antenna that can be erected of the same dimensions will bring in the noise interference waves at maximum strength. Improvements in conductivity and insulation will increase the strength of the desired signals and will therefore increase the signal to noise ratio, this because the noise has already reached its maximum and can increase no further. Perfect insulation should be used throughout. Enamelled solid copper or copper-clad steel wire is best for flat top and lead-in, and needless to say all joints should be well soldered. High frequency currents are conducted almost entirely on the surface of the wire, hence this surface should be copper. The lead-in should be spaced out from the building as far as possible, and brought through the wall with a high grade insulating bushing.

Equally important, and much less appreciated is the ground. In the days of crystal sets and spark transmitters, when we had to conserve every bit of energy to get enough to actuate the headphones the ground was given the consideration it deserves. Look at some back copies of "RADIO", or PACIFIC RADIO NEWS if you go back far enough and see to what extremes the amateurs went to get good ground connections. Copper plates, wire and screening were buried all over the lot, with separate ground wires coming in to a common central "ground" connection. A ground is a matter of **position** as well as of connection. Thus, there is no method by which a radio set on the second story of a house can really be grounded. True, it may be connected to a wire that goes straight down to moist earth at a spot directly underneath, but regardless of what we may elect to call it, the fact remains that such a set is connected to the top of a 15 or 20 foot antenna which is grounded at the lower end. To be completely grounded a receiver must be located right at the level of permanently moist earth. This is both impractical and inconvenient although it is done in commercial receiving stations. It nevertheless is a most important factor in determining receiving range, and the lower the set can be located the greater will be the receiving range with the same antenna.

(Continued on facing page [lower half])

QUARTZ CRYSTALS AND THEIR APPLICATIONS

GRINDING YOUR OWN

By W. W. SMITH, W6BCX

IN SPITE of the fact that finished crystals can now be obtained almost as cheaply as rough blanks, many amateurs still prefer to grind their own plates. In this class is the amateur who is well fixed financially but takes pride in constructing his transmitter and not just assembling it—the ham who drives a Packard but insists upon winding his own transformers and chokes. Then there is the ham who, because of financial stress, must count the pennies; yet appreciates the advantages of having several crystals for QSY when QRM gets too hot or for changing bands. In this article I will endeavor to show how to finish up rough blanks for maximum output with a minimum of labor and grief.

When ordering blanks, it is well to specify the band the crystals are to be operated in as well as the preferred cut, because grinding a 160 meter blank down to 80 meters by hand entails considerable elbow grease. Much time can be saved by procuring blanks that do not run over .008 or .01 inch greater than the calculated finished thickness.

Amateurs who have had no previous grinding experience will do well to first attempt a Y cut 80 or 160 meter crystal. Although it takes no longer to grind an X cut after one has become proficient, they must be finished with a greater degree of precision and are therefore best avoided by the novice for the first attempt. By finishing with the proper contour and using a low "C" oscillator tank circuit, a Y cut crystal will have but one major frequency response and a continuous temperature curve over the normal range of operating temperatures. It is not necessary to resort to a clamp-type holder with heavy pressure—the trick is in shaping the surfaces. Thus, the "X cut versus Y cut" controversy resolves itself into a question of frequency creep. The temperature coefficient of a Y cut plate is about twice that of an X cut plate, but if the oscillator is run underloaded as it should be, the drift will be negligible with a crystal of either cut.

The necessary materials and equipment for doing a good job include a micrometer, several pieces of heavy plate glass, an oil can filled with water, a pan of clean water, several clean towels, a bottle of India ink, a test oscillator, and small quantities of No. 150, No. 280, and No. 400 carborundum. The latter grain is used only in finishing X cut plates. Water is used in preference to kerosene, because it would be necessary to remove all trace of kerosene each time a crystal was tested in the oscillator. A half-inch micrometer reading to ten-thousandths is best adapted for thickness measurement, but a one-inch instrument reading to thousandths will measure close enough for Y cut plates by estimating to ten-thousandths, and with care can even be used for X cuts if nothing better is available. It is advantageous to grind down the movable face of the micrometer on a wheel so that the tip resembles a cone with a rounded point, rather than the end of a cylinder. This enables one to measure a point on a crystal instead of a section of the crystal. Of course, if the micrometer is a borrowed affair, or is to be used for shop work, such procedure would be out of the question. Excellent work can be done, however, with a regular, standard micrometer with flat faces.

The test oscillator should be equipped with a plate milliammeter, a dummy load which can be cut out of the circuit, and plug-in inductances so that either low or high "C" may be used in the tank circuit for test purposes. An RF meter in the grid circuit is handy, but not absolutely necessary.

(Continued on page 24)

Reducing Noise Level

(Continued from facing page)

An actual case in point will illustrate the importance of this. Before the war the writer had an amateur station in San Francisco in a fairly good radio location, and had a 400 foot, two wire antenna. This was not an uncommon antenna in those days. The radio set was located on the second story of the house, some 20 feet above ground. In those days the ambition of all West Coast amateurs was to hear NAA's time signals and weather report at 7:00 p.m. (our time). Some were able to do it, but the writer had no success with a crystal set or later with a very good regenerative tube set. During the war all amateur stations were dismantled. When the lid was removed again in 1919 the same antenna was reinstalled but the radio set was located in the basement. Crystal sets were out of date by that time, but with a one tube regenerative set NAA could be heard every night and at times was loud enough to read ten feet from the headphones! It might be stated that the same receiving tube was used—a carefully preserved Audiotron, forerunner to the present Cunninghams—and the receivers were of about the same sensitivity. Noise level was not increased by this change of receiver location, so that the gain in signal strength and range was entirely beneficial.

Looking back, it appears that in every single case of extreme long distance reception with which the writer has been associated a long antenna has been involved, and these cases are too many for this to be mere coincidence. In the post-war installation described above there was also a transmitting antenna consisting of 12 wires 40 feet long, spaced one foot apart. At times the transmitting antenna was used for receiving in place of the 400 foot one. Comparing reception on the two it was found that from four to six times as many stations could be heard with the large antenna as with the small one, but that static and noise was in there with either. The important point is this. Signals were in there, above the static level with the large antenna which could not be heard at all with the small one, although static was still present in somewhat reduced amount.

A few months after war was declared the writer was assigned to the spark watch at NPG, on top of Goat Island in San Francisco Bay. For receiving we used a single wire antenna that went from a 100 foot pole on top of the Island (which in itself was 500 feet above the Bay) down to a tree 600 feet away. Nightly from 2 to 5 a.m. we could hear VKT and VMR, 5 K.W. spark stations in Australia, on our none-too-good crystal receiving set, this on a wavelength of about 2000 meters. Probably the carrying power of those spark sets was no greater than that of the more powerful amateur sets now used by the VKs and the ZLs, but imagine what would happen nowadays if someone should pick them up with a crystal!

Later the writer was assigned to the subchaser flotilla at Base 25, Corfu, Greece—where Greek meets Greek! The only newspapers we could get were printed in French or Italian, except of course the ones that were in Greek and which we won't bother mentioning. We all had a yen for news from the States and so it was up to the radio force to get it. We built a receiver to cover 3000 to 15000 meters, using a one tube regenerative detector, and then strung a 1000 foot antenna along the tops of the olive trees, pointing approximately east and west. With this for an energy pickup, and with a good ground we were able to get press from NWW, NSS, NDD and NFF even through the summer static, and once or twice picked up time signals from NPG and NPL on the West Coast. Again a long wire was involved.

After the war the writer located for a while in Brooklyn, N. Y., with still a craving for DX and with a roommate who felt the same. Looking around for an antenna location we found that an abandoned telephone line ran through the backyard on poles about 75 feet high. The line ran for blocks in each direction, and this was too much even for hams, so we cut the wire 300 feet to either side, attached a lead-in at the center and connected up our one tube honeycomb coil receiver. On 600 meters signals from the Carribbean Sea and from South America could be copied almost nightly, also NAX at Colon, and several West Indies stations. Was the long wire responsible? It begins to look like it.

Other incidents could be cited, but those already given will suffice. The writer has not been in position to make any recent tests of long vs. short antenna and what has been given here is merely speculative, but there seems to be a preponderance of evidence pointing the way to the lost art of getting distance. With the really good receivers that can now be had who knows what DX we could do if we gave ourselves the breaks in this direction?

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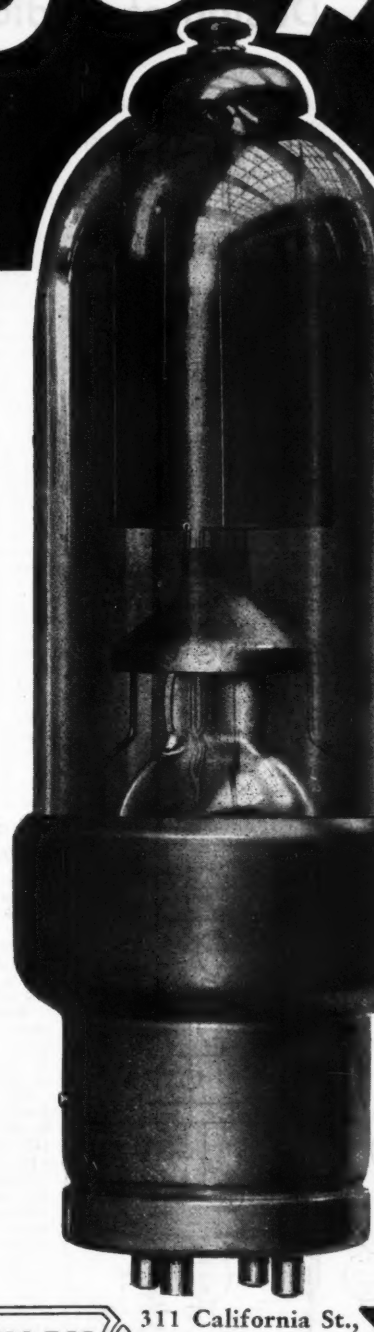

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Two of the more important design features of the 2A3 are its multifilamentary cathode and its extremely high mutual conductance. The multifilamentary cathode consists of a large number of coated filaments arranged in series-parallel combination to provide a very large effective cathode area.

Graphical Solution for the Selection of 2A3 Operating Conditions

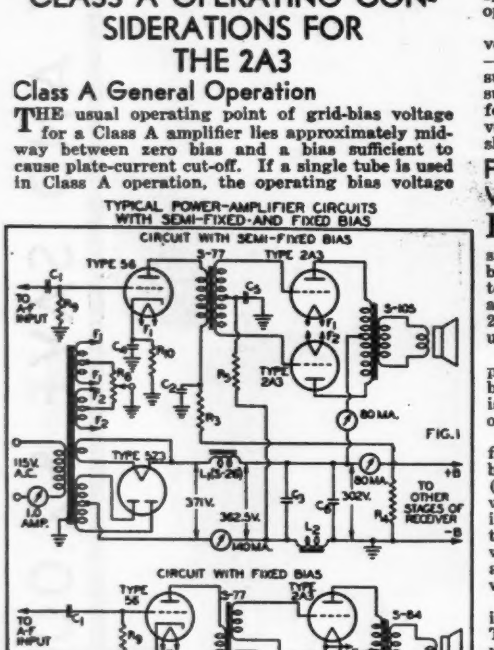
In determining the performance obtainable from two 2A3's in Class A push-pull and in selecting output transformer constants, a graphical method of solution can be used. For a general consideration of the method for determining the performance of push-pull audio amplifiers by graphical means, see the paper entitled "Graphical Determination of Performance of Push-Pull Audio Amplifiers" by B. J. Thompson of our Research and Development Laboratory. This paper appeared in Proceedings of the Institute of Radio Engineers for April, 1933.

CLASS A OPERATING CONSIDERATIONS FOR THE 2A3

Class A General Operation

THE usual operating point of grid-bias voltage for a Class A amplifier lies approximately midway between zero bias and a bias sufficient to cause plate-current cut-off. If a single tube is used in Class A operation, the operating bias voltage must be such that the DC plate current does not change appreciably when full signal voltages are applied to the grid. Only under such conditions can an output having low distortion be obtained.

TYPICAL POWER-AMPLIFIER CIRCUITS WITH SEMI-FIXED-AND FIXED BIAS



APPROXIMATE VALUES

C_1 = BLOCKING CONDENSER—0.01 µf	R_2 = 200000 OHMS
C_2 = BY-PASS CONDENSER—0.25 µf	R_3 = 10000 OHMS
C_3 = FILTER CONDENSER—10 µf	R_4 = BLEEDER
C_4 = BY-PASS CONDENSER—5 µf	R_5 = 50000 OHMS
C_5 = BY-PASS CONDENSER—0.05 µf	R_6 = 22000 OHMS
C_6 = FILTER CONDENSER—5 µf	R_7 = CENTER-TAPPED POTENTIOMETER—2500 OHMS
L_1 = FILTER CHOKE—10 HENRIES AT MAX. MA., 60 OHMS	R_8 = POTENTIOMETER—100 OHMS
L_2 = SPEAKER FIELD—430 OHMS	R_9 = 0.5 TO 1.0 MEGOHM
L_3 = SPEAKER FIELD—1800 OHMS	R_{10} = 2700 OHMS
R_1 = 5000 OHMS	

Strictly speaking, no type of output tube has absolutely linear characteristics. Consequently, a small amount of rectification of the signal voltage usually occurs. The non-linearity of characteristics is therefore responsible for the distortion produced by the tube.

When two tubes are operated in a Class A push-pull circuit, the non-linear sections of their characteristics are made to complement each other to give a substantially linear overall characteristic. This method produces an output free from second harmonic distortion. For this reason, it is possible to use a higher bias voltage for push-pull operation than is usually employed for single-tube operation. An increased bias voltage lowers the internal dissipation of the tube and permits the use of higher plate voltages. Higher plate voltages, in turn, make possible higher power output.

In order to obtain the higher power output of which the 2A3 is capable, two of these tubes are operated in push-pull under bias-voltage conditions which cause considerable rectification in each tube. Additional plate current, then, is drawn because of rectification, but this increased plate current is useful in securing higher power outputs. Under normal recommended operating conditions in a push-pull amplifier, where a plate-supply voltage of very good regulation and a fixed-bias supply voltage are used, the plate current is not cut off during any fraction of the cycle. Consequently, even though the recommended operating conditions specify over-bias grid voltage, this system may be operated as a strictly Class A amplifier.

2A3's should not be operated with more than 300 volts on the plate. The grid-bias voltage should be —62 volts when operated from an AC filament supply and —60 volts when operated from a DC supply. The corresponding static plate current for an average 2A3 is 40 milliamperes. This voltage and current rating for no signal input should not be exceeded for best results.

Fixed-Bias Operation of the 2A3 With Over-Bias Voltage

FIG. 2 shows a circuit arrangement for the 2A3 in which the bias voltage is obtained from a small triode used as a rectifier. This triode must be a type whose cathode comes to an operating temperature quickly in order that bias will be available to prevent abnormal plate current in the 2A3's. Either a type 26 or 01-A is suitable for use as the bias rectifier.

With the circuit of Fig. 1, changes in the DC plate current of the 2A3 produce some change in bias. With the circuit of Fig. 2, the bias voltage is substantially independent of the plate current of the 2A3's.

The ideal case of fixed-bias operation with a fixed plate-voltage supply gives results as shown by the curves marked (I) in Fig. 3. The curves (II) show the performance with fixed bias but with a plate-supply source having an equivalent internal resistance of 562 ohms. This represents the condition for the circuit of Fig. 2 when a 5Z3 with suitable transformer is used. The performance with an 83 type is intermediate between the values of curves I and II of Fig. 3.

The plate circuits of the 2A3's should be fused in the center-tap lead of the output transformer. This is especially important when fixed bias is used. Should the bias-voltage rectifier tube be removed or damaged, the bias on the 2A3's becomes zero. In that event, unless a fuse is provided for protection, excessive plate current can flow and damage the receiver. A suitable fuse is one similar to the small glass-enclosed type often used to fuse the power-supply line in radio sets and rated at 150 milliamperes.

Self-Bias Operation of the 2A3 With Over-Bias Voltage

WHEN 2A3's are operated in a push-pull circuit and are self-biased, a rise in DC plate current with increasing signal voltages increases the voltage drop across the self-biasing resistor and raises the bias on the tubes. Thus, the operating point on the plate family of the characteristic curves is shifted downward. This shift tends to increase distortion and to lower the power output. Under these conditions, operation intermediate to Class A and Class B is usually obtained at full output since the plate current is cut off for an appreciable fraction of the operating cycle.

When self-biasing circuits are used for the 2A3, it is necessary, therefore, to employ a higher value of plate-load resistance than is used with a fixed or semi-fixed bias arrangement. The purpose of this high resistance is to lessen plate-current swings, limit distortion, and prevent plate-current cut-off at negative signal swings.

Performance of a 2A3 amplifier for self-bias operation (self-bias resistance of 780 ohms) and an assumed internal resistance of the plate-voltage supply of 562 ohms is shown as Curve IV in Fig. 3. A comparison with Curve I, which represents the ideal case of fixed supply voltages, shows the necessity of using a high plate load, as previously stated, in order to obtain high power output and low distortion. Increasing the internal resistance of the plate-voltage supply to the somewhat higher values often used commercially will not materially change results from the values of Curve IV.

The circuit diagram in Fig. 3 shows the equivalent voltage-supply circuit for the plate and grid-voltage supply. The plate and bias voltages on the power tube at zero-input signal are 300 and —60 volts, respectively. (For AC filament supply, grid-bias voltage is —62 volts).

Curves I to IV show the performance of the amplifier for four combinations of the internal resistance values of the plate-voltage and grid-voltage supply. The plate- and grid-supply voltages are adjusted to the values given above. These curves show that it is desirable to use a bias arrangement which will not give bias-voltage fluctuations when the DC plate current changes. Semi-fixed and fixed-bias arrangements allow higher power output levels to be maintained with a high degree of fidelity.

Semi-Fixed-Bias Operation of the 2A3 With Over-Bias Voltage

FIG. 1 shows a circuit arrangement employing semi-fixed bias for the 2A3. The bias voltage is obtained across the speaker-field resistance. Since the plate current for all of the tubes in the set flows through this resistance, the bias voltage is less affected by the DC plate-current changes in the 2A3's than it is in a self-biasing circuit.

OPERATION CHARACTERISTICS

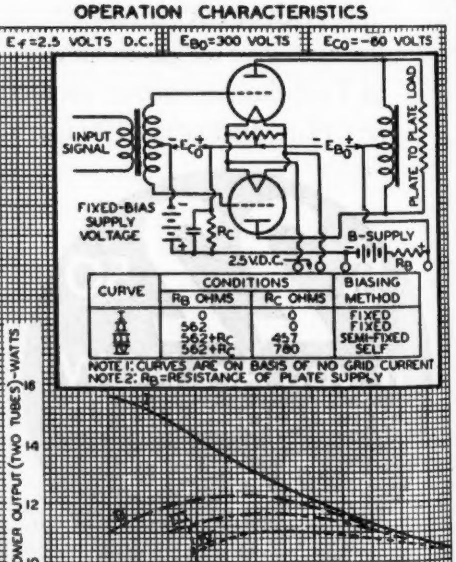


FIG. 3

The circuit constants shown in Fig. 1 are those for a typical receiver. Since the speaker-field resistance determines the 2A3 bias, it follows that the choice of resistance depends on the total plate-current drain of all the tubes in the set. The performance with this circuit is represented by Curve III.

Balancing of 2A3 Circuits

IT MAY be advisable to provide some means for balancing the plate currents of the 2A3 tubes, as this has the effect of balancing out hum voltages present in the plate-supply voltage.

Two methods of accomplishing this are shown in the circuit diagrams. In Fig. 1, a small potentiometer (R_8) is connected between the center taps of the filament windings to permit an adjustment of bias voltage. In Fig. 2, the secondary of the input transformer consists of two separate windings. One lead is attached to the center of the potentiometer (R_7) and the other to the slider or arm of the same potentiometer. Adjustment of the potentiometer varies the bias slightly on one of the 2A3's.

Small amounts of hum due to various causes can often be eliminated by adjustment of the potentiometer. Adjustment of the potentiometer for minimum hum usually gives equal plate currents. The potentiometer is adjusted by listening for minimum hum upon installation of the 2A3's in the set. It should not require readjustment until one of the 2A3's is changed.

Power Transformer

BOTH the circuits of Fig. 1 and Fig. 2 are designed for use with typical commercial power transformers. There are no special features involved in the design of the power transformer. Any make of transformer having the appropriate voltage windings, correct rating, and good regulation may be used.

Pre-Amplifier Stage

A TYPE 56 tube is used in the pre-amplifier stage, since this tube gives excellent power sensitivity. The 56 also is an economical type.

A plate-supply voltage of 200 volts for the 56 is adequate to give the output signal required to swing the 2A3's. This is the voltage available for plate supply to the other tubes in the set under conditions given in Figs. 1 and 2. The 56, with 200-volt plate supply, is operated with a bias of —11 volts. The plate current is 3.6 milliamperes.

Input Transformer

THE same input transformer, specifications for which are shown here, is used for both the semi-fixed and fixed-bias arrangements. Commercial-size audio-transformer laminations are used.

The ratio of the input transformer is 1.4 to 1 from the full primary winding to one-half of the secondary winding. The peak voltage which will be induced in the secondary winding is 2 x 90 or 180 volts at the point at which the 56 begins to draw grid current.

In determining the constants for the input transformer, cost, size, response characteristics, and signal requirements must be considered. In order to obtain a low-cost small-size transformer with primary inductance high enough to give good frequency characteristics, a step-down ratio is used. A step-up ratio would require a larger transformer design in order to provide space for the additional secondary turns. However, under the circuit conditions shown, the step-down ratio can give a signal input to the 2A3's sufficiently large to obtain their full output.

Transformer Specifications

Power Transformer S-79A*

CORE:
Material—Transformer Steel
Allegheny Steel Co. or equivalent
Punching—EI-13A
Stack—1¾-in.
Weight—4.9 lbs.

PRIMARY:
Resistance—2.4 ohms

SECONDARY:
Resistance at 25°C—2 x 106 ohms
Induced voltage—2 x 375 volts RMS
Induced voltage from center-tap to tap for bias rectifier—approx. 57 v RMS
Total weights of copper—1.0 lb.

Input Transformer S-77 *

CORE:
Material—Audio B
Allegheny Steel Co. or equivalent
Punching—EI-75
Stack—¾-in.
Joint—Butt
Weight—0.6 lb.

PRIMARY:
Turns—5000
Location—Between two halves of secondary winding
Turns per layer—240
Layers—21
Insulation between layers—0.001-in. paper
Wire—No. 40 enamelled
Resistance at 25°C—2000 ohms

SECONDARY:
Turns—Two windings of 3600 turns each
Location—One-half over, one-half under primary
Turns per layer—240
Layers—2 x 15
Insulation between layers—0.001-in. paper
Wire—No. 40 enamelled
Total weights of copper—0.14 lb.

Output Transformer S-84 *

CORE:
Material—Audio C
Allegheny Steel Co. or equivalent
Punching—EI-11
Stack—⅞-in.
Joint—Lap
Weight—1.0 lb.

PRIMARY:
Wire—No. 32 enamelled
Turns—1400 tapped at 700
Location—Next to core
Turns per layer—105
Layers—14
Insulation between layers—0.0015-in. paper
Resistance at 250°C—98 ohms

SECONDARY:
Turns—32
Location—Wound over insulated primary
Wire—No. 15 enamelled
Turns per layer—16
Layers—2
Insulation between layers—0.005-in. paper
Secondary load—Voice coil of electro-dynamic speaker having an impedance at 60 cycles of 1.06 ohms.
Resistance at 25°C—0.053 ohms
Output—13.3 watts into a 1.06-ohm load at 60 cycles
Total weight of copper—0.24 lb.

Choke S-26 *

CORE:
Material—Dynamo Steel
Allegheny Steel Co. or equivalent
Punchings—EI-12
Stack—1¼-in.
Air gap—0.004-in. x 2
Weight—1.88 lbs.

WINDING:
Turns—1780
Turns per layer—81
Layers—22
Insulation between layers—0.003-in. paper
Resistance at 25°C—approx. 60 ohms
Weight of copper—0.47 lb.
Inductance—approx. 10 henries (conditions as in Fig. 2)

Output Transformer S-105 *

CORE:
Material—Audio C
Allegheny Steel Co. or equivalent
Stack—0.875-in.
Joint—Lap
Weight—1.0 lb.

PRIMARY:
Turns—2000 tapped at 1000
Location—Next to core
Wire—No. 33 enamelled
Turns per layer—118
Layers—17
Insulation between layers—0.0015-in. paper
Resistance at 25°C—172 ohms total
Inductance—19.5 henries (at full signal)

SECONDARY:
Location—Wound over primary
Turns—2000 divided by the square root of $[5400/(R_L+r_z)]$ where,
R_L=external load resistance on secondary terminals
r_z=resistance of secondary winding or approximately 6% of R_L.

* Our design identification number.

The Banehawk Superheterodyne

(Continued from page 5)

cannot get into the RF end due to the difference in frequency. The only coupling between the detector and oscillator is directly into the electron stream of the detector . . . a highly desirable condition. Provision is made to vary the amount of oscillator voltage fed to this first detector by means of a simple potentiometer system. Because tubes vary with use, it sometimes becomes necessary to increase the coupling between the two stages, which can be done by simply turning a slotted shaft from the side of the receiver.

By utilizing the second harmonic of the oscillator, the number of coils necessary to cover any amateur bands are reduced in number. The detector coil has no tickler or regeneration winding and this coil, used as a detector coil on 7 MC, can become the oscillator coil for 14 MC operation. By the same token, the 14 MC detector coil becomes the 28 MC oscillator coil. This system is of particular advantage to those who have sets of coils from old commercial-built TRF sets.

Plug-in coils are used for very obvious reasons. When some manufacturer gives us a coil catacomb without unwanted coupling between coils and with coils that have as high a "Q" as good plug-in coils, and whose switching arrangement never gets worn or dirty, we will give up our simple, cheap and wholely effective plug-in coils.

The receiver panel is of the standard relay-rack size, 8¾ inches by 19 inches. The cabinet portion is within the necessary 17-inch clearance for relay rack mounting and gives ample clearance between the uprights. This type of construction is admirably suited to amateur use—any stage can be taken off in a few seconds and a new one installed.

While it is not within the scope of this article to go into mechanical details (this subject being reserved for the next and last instalment), we do not feel that we should overlook one mechanical detail that is very important. All ground leads are brought directly to a center partition which runs the full length of the receiver. This acts as a common bus and eliminates potential differences in the ground leads. All of these leads are extremely short and direct and this fact, coupled with the first mentioned feature, adds in no small way to the elimination of grief usually associated with high-gain, regenerative amplifiers.

A summary of the electrical features in the Banehawk gives us the following: (1) A highly efficient RF amplifier which provides real gain and selectivity. (2) A first detector whose conversion gain is not dependent upon the Grace of the Gods and (3) An oscillator with real stability and adjustable output, in addition to freedom from noise.

This receiver is not the sort that can be built entirely from the junk box, but rather the very finest we have been able to develop with the tubes and equipment available today. It is regrettable that it is not possible to present the complete story in one issue, owing to the large amount of theory and practical data which must first be given.

Next month's story will be devoted to the actual mechanical and electrical constructional details of this really-different high-frequency unit. We have not the slightest hesitancy in saying that if this unit were to be built and used as a TRF receiver, the performance would excel that of any other TRF set that has been shown to date.

Grinding Your Own

(Continued from page 20)

In view of the fact that blanks purchased from reputable manufacturers are almost certain to make good oscillators, it is a waste of time to parallel the faces and test a blank for oscillation before roughing it down. The practice of finishing up alternate blanks as cut from the quartz makes it possible for a manufacturer to give a reasonable assurance that the blanks he sends out will oscillate if finished properly. It is not necessary to pay finished-crystal prices for a tested oscillating blank in order to make sure the blank will make a good oscillator. The rough blanks are cheaper and just about as easy to finish up.

We will presume that you have the necessarv materials and a 160 or 80 meter Y cut blank which you desire to convert into a good finished crystal. It is first necessary to finish one side flat to use as the reference side (some blanks have the reference side already finished and marked). This can be done by rubbing one side around with even pressure on a piece of plate glass that has been smeared with No. 150 carborundum grain and water until India ink marks which have been placed on the tip of each corner disappear. The crystal is then rinsed in the pan of water and rubbed on another piece of plate glass, covered with No. 280 grain carborundum and water, for a half minute or so—care being taken to see that the pressure is fairly even all over the crystal, and that the grinding is being done on the same side. The crystal is then washed, dried, and one corner of the finished side marked with India ink. All subsequent grinding is done on the other side. Using a finer grain of abrasive for finishing Y cut crystals is not advisable, because it does not increase the output but does aggravate the tendency toward twin-frequency peaks. By using a medium grain of carborundum for finishing, and by giving the right contour to the side that is not yet finished, the second peak can be entirely eliminated.

The crystal should now be roughed down with No. 150 grain carborundum until it is .002 or .003 in. thicker than the calculated finished thickness, which will be very close to .022 in. for 3500 k.c.s, and .0435 in. for 1750 k.c.s. The finished thickness of a crystal of either cut can be predetermined for a given frequency within very close limits by applying the corresponding formula at the end of this article. The crystal is next finished down with the No. 280 abrasive to about .0004 in. greater than the calculated thickness—frequent micrometer readings being taken to prevent any high or low spots from appearing. The crystal is then put in the oscillator, and, if its surfaces are reasonably parallel, it should now oscillate. If it oscillates at but one frequency as the tank condenser is varied, it is a most unusual Y cut crystal and is not acting in characteristic fashion. Making sure that it is oscillating at the low frequency peak, the frequency should be checked to see how close it is agreeing with the formula. We can now proceed to get rid of the second peak (the higher frequency one) by giving the face we are working on a convex contour. The degree of convexity necessary to give one-frequency operation will vary with different crystals, but in every case the second peak will disappear before the process is carried far enough to affect the output. In fact, a moderate curvature will actually increase the output slightly over that of a Y cut plate that has been ground with both sides perfectly flat.

At this point the edges should be finished up and the corners rounded. It is best to finish them before putting the final touches on the crystal, because it will sometimes affect the characteristics of the plate slightly. Grinding on the edges has a minor effect on the frequency, and also will sometimes cause a crystal that checks at one frequency to develope a second peak.

The optimum amount of convexity can only be determined for each particular crystal by trial, but it is not critical so long as no spot is higher than the center of the crystal. A contour that has been found suitable for most 80 meter Y cut crystals is as follows: Edges between corners, .0001 in. lower than center; corners, .0003 to .0006 in. lower than center. For 160 meter crystals the convexity should be slightly greater. A piece of glass that has been worn down a bit facilitates grinding a uniform convex contour, but until one has used a piece for roughing down several crystals it won't be hollowed out enough to do much good. If the glass is nearly flat, pressure on each of the edges and corners—one at a time—will be necessary to get the desired curvature.

A final check for twin frequencies is made by using a tank coil in the test oscillator that takes considerable capacity (.00025 mfd or so at 80 meters) to tune to resonance. If two frequencies are present, it will be necessary to grind down the tips of the corners until the second one disappears. A soldering iron should then be held near the crystal as the beat note is monitored in the receiver, until the crystal creeps 10 or 15 k.c.'s. The tank is then tuned through resonance. There should still be but one frequency. If not, take still more off the tips of the corners of the plate. Very few crystals will be found to require such drastic treatment—the slight convexity usually being sufficient.

To test for output and freedom of oscillation, the original low "C" tank coil is employed. It is helpful to have a crystal that is known to be a good oscillator on hand for comparative purposes. A low value of minimum plate current is the criterion for freedom of oscillation. A low minimum plate current means nothing, however, if the crystal becomes unstable or goes out of oscillation the minute a load is coupled to the tank. The oscillator should stand a reasonable amount of loading without going out of oscillation.

If the finished crystal gives good output and has only one frequency, you will then be justified in attempting to grind an X cut plate.

The reference side of an X cut blank is ground down with No. 150 and No. 280 grain carborundum in the same manner as a Y cut blank. It is then rubbed around for a half minute on a fresh piece of glass that is covered with No. 400 grain and water. Using the index finger to exert light pressure in the center of the crystal, the crystal can be continually turned with the middle finger while making circular arm motions over the No. 400 abrasive. It is imperative to use a fresh piece of glass for finishing the reference side of an X cut blank, because an X cut crystal will not work well if either side has the slightest suggestion of a convex curvature. The output of X cut plates can be boosted by grinding them slightly concave on the finishing side. Paradoxically, while Y cut plates have twin frequencies when the curvature is not great enough, X cut plates exhibit double frequencies only when the curvature is too great. It is necessary, however, to take quite a chunk out of the center of an X cut crystal before the second frequency appears. Grinding the center of an X cut 80 meter crystal .0002 in. low will boost the output without encouraging a second frequency.

After inking the reference side, the blank is roughed down to about .003 in. over the calculated finished thickness with No. 150 grain, and then down a bit more with No. 280. The final grinding is done on a little-used piece of glass covered with No. 400 and water. Enough pressure is exerted by pressing with one finger in the center of the crystal to bring the center .0001 or .0002 in. lower than the edges and corners. No spot should be lower than the center, or the output will be disappointing. A fresh piece of glass should be used for finishing each X cut crystal. The glass is then still suitable for grinding Y cut crystals or roughing down X cuts.

As 160 meter X cut crystals are too thick to be hollowed out easily by exerting pressure in the center even if fresh pieces of plate glass are used, it is necessary to finish them on a special piece of convex glass. For that reason it is not advisable to attempt 160 meter X cuts unless one has the necessary special equipment.

Finishing of the edges on X cut plates is of greater importance than on Y cuts. An X cut plate with unfinished edges may even refuse to oscillate unless the edges and corners do not vary over .0001 in. A crystal with greater variation may give full output, however, after the edges are finished. For this reason it is important that every last nick be removed from the edges when finishing X cut crystals. In any event, unless the crystal has been ground to an exceptionally high degree of precision, careful finishing of the edges will boost the output of X cut plates.

The following hypothetical measurements will serve to show the desired contour as well as the permissible thickness tolerance of an 80 meter X cut plate: Corners, .0318, .0317, .0318, .0318. Edges between corners, .0316, .0317, .0317, .0316. Center, .0315. A crystal with an ideal contour would have all points in each group the same, with the second group .0001 less than the first, and the center .0001 or .0002 lower than the second group. For 40 meter crystals, the allowable tolerance for maximum output is reduced to one-fourth that of an 80 meter plate. And as their thinness presents additional grinding difficulties, the layman should be discouraged from attempting to grind them. For that reason the grinding of 40 meter plates is not discussed in this article.

Finished X cut crystals can be tested for output in the same manner as previously described for Y cuts, disregarding all references to twin frequencies.

To finish the edges of crystals of either cut, all nicks are first ground out using the same grade of carborundum as used to finish the faces, but with slightly less water. To complete the job, the corners and edges are then rounded off a bit.

The India ink reference mark can be removed with a moistened, soft rubber eraser. The plate should then be washed with soap and warm water to remove any rubber gum which might adhere to the unpolished surfaces of the crystal.

X cut crystals can be polished up water-clear with rouge, but the output will not be increased, provided a fine grade of abrasive has been used for the finishing grinding.

Formulae:

X cut $T = \frac{112.6}{F}$

Y cut $T = \frac{77}{F}$

**When T is the thickness in inches
F is the frequency in kilocycles.**

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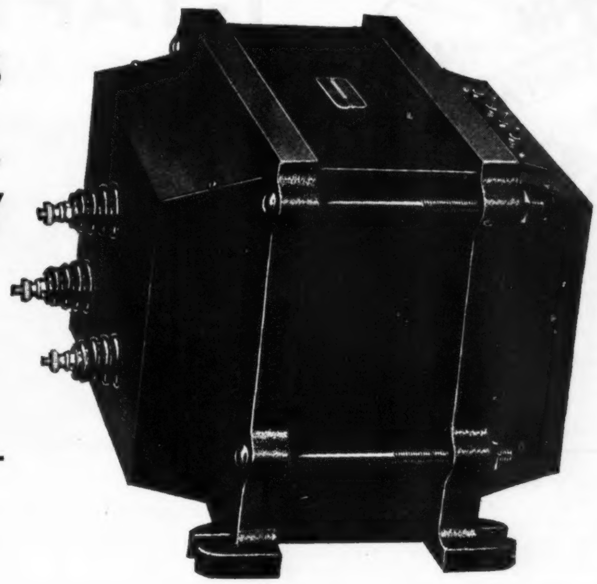

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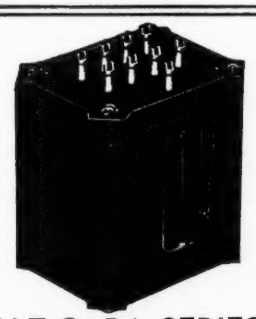

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- LS-98 Swinging class B choke. 8-40 Henrys 400 M.A.; 90 ohms D. C.
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- LS-76 Heavy duty plate supply transformer for Class B 203 output stage.
- LS-85 Filament transformer for 866 and 203 filaments, 10,000 volt insulation.
- LS-79 C bias plate supply transformer for 203 tubes.
- LS-97 Swinging Class B choke for C bias supply. 8-40 Henrys 200 M.A.; 100 ohms D. C.
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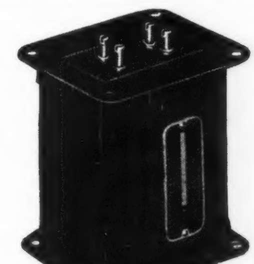

THE UTC PA series of audio, filter and power units for the 800 and RK-18 Class B tubes are designed to satisfy the demand for a popular priced quality line having the many exclusive universal features associated with UTC products.

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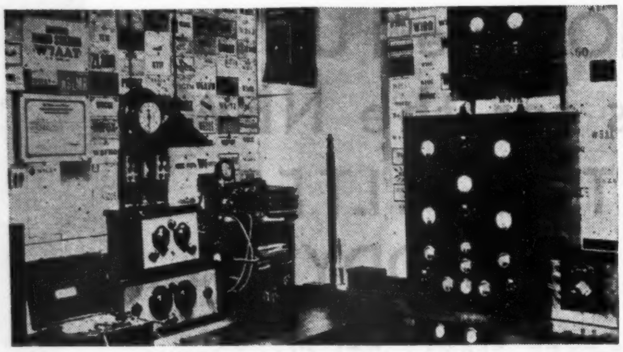
I-TAPPA-KEE News

THE AMATEUR'S LEGION OF HONOR

This department is edited by the Hi-Kilowatt of the ITK Radio Fraternity, J. Richard Meloan (Jo) radio W6CGM-W6ZZGM KERN, 1302 "M" St., Bakersfield, California.

All communications concerning the I-TAPPA-KEE RADIO FRATERNITY, as well as inquiries from any amateur as to the Requirements for Membership, should be addressed to I-TAPPA-KEE HEADQUARTERS, either to the Secretary-Treasurer, Kenneth M. Isbell, W6AMR-W6BOQ, 5143 So. 6th Ave., Los Angeles, or to The Hi-Kilowatt, J. R. Meloan, W6CGM-W6ZZGM, 1302 "M" St., Bakersfield, California.



ITK STATION W7AAT

February Speedometer Contest

A NOVEL and exciting radio contest has been outlined by the Chief of Communications for Feb. 20th and 21st, Saturday and Sunday, with a prize for the winner. It's a "sky-miles contest" for very low power, and the ITK man who totals up the most sky-miles will be declared the winner of the contest. Here's how it works: Contest is open to all ITK brothers. Only a '30 or '99 type tube can be used in your transmitter, either as a self-excited oscillator or final amplifier. Your power input will be determined only by what you can induce a '30 or '99 tube to dissipate. Remember, only one tube can be used as the self-excited oscillator or final amplifier—**that means no push-pull.** Now that the technical details have been taken into consideration, here's the object of the contest: (1) QSO any stations you wish, ITK or otherwise, on any band. (2) Count your sky-miles (air distance in miles) to each station you QSO. (3) Add together the sky-miles of each QSO as though you were flying to each station and using an air speedometer. (4) Total miles for your total QSO's will be your final score.

This contest gives everyone an equal opportunity. For instance, one ITK may only be able to work stations in a city 100 miles away, but suppose he works 20 stations in that city . . . then his score is 20 x 100 equals 2000 sky-miles. But another ITK working on a high-freq. band may QSO one station 2000 miles away; then his score is 2000. So results will depend on how many stations you QSO as well as their distance from your station. The time: Saturday 6 a.m. to Sunday 6 a.m. local time, Feb. 20th and 21st. Submit results to Headquarters as soon as contest is over. Let's go!

●●●

"CQ-ITK" Contest

AS THIS goes to press, not all of the scores are in for the recent Xmas contest so the results cannot be published until the next issue. Partial results show plenty of activity with some of the boys going the three-way QSO feature one better with four and five way QSO-parties, in true ITK fashion. We might say that this is old stuff to fraternity men, for as many as ten or more ITK frequently get together on the air for "air meetings" and a general good time. However, such meetings are scheduled, while the multiple QSO's during the contest "just happened". Hi. The first prize in this contest is a Hygrade-Sylvania Carbon Plate 210, kindly donated to the fraternity by the Radio Supply Co. of Los Angeles, through its representative Mr. Henderson. We'll tell you who the lucky man is in the next issue.

●●●

Divisional Chiefs

W7AVL, Leo Perras, of KFPY at Spokane, Wash., is appointed Chief of the Olympia Division and takes charge of members in the states of Oregon and Washington, as well as all of Alaska. He will have supervision over the State Chiefs and the Alaskan Territorial Chief.

W9SU, Louis R. Huber of Tipton, Iowa, is active as Chief of the Central Division, embracing the important states of Kansas, Nebraska, North Dakota, South Dakota, Missouri and Iowa. He is building up his division and the names he is pledging reads like a "Who's Who of the Middle West", not to mention his pledges for many prominent amateurs all over the country. This boy Huber has been places and knows 'most everybody who has accomplished anything.

W2ADQ, James E. Shannon of Long Island, N. Y., heads the Atlantic Division with W2BPY, Robt. Maloney, as State Chief of New Jersey.

All Chiefs are carefully scrutinizing amateur applications from their areas. Appointments will be made for both Divisional and State Chiefs in the Southern and Southeastern United States as soon as this area has sufficient ITK men to warrant such appointments, as well as men eligible for these high positions. All other sections of the United States are now properly supervised. Appointments for Chiefs of Canadian provinces are now under consideration with vacancies open for all foreign countries.

OWNED and operated by Orvy Viers at Red Lodge, Montana. W7AAT has established a most enviable record in its seven and a half years of existence for its consistency of operation can be matched by but few amateur stations. A total of over 10,000 two-way contacts bears mute evidence of this consistency with his signals having been reported in all parts of the world with many foreign countries QSO'ed. In the Sweepstakes Contest W7AAT took first place for his section in all three contests. He placed third for the entire U. S. and Canada in the second contest, with a score of over 29,000 points. This work was done entirely by Orvy himself without the aid of relief operators.

Technically, the layout at W7AAT consists of a 47 xtal osc. followed by two 210 stages and a 203A in the final with 300 watts input. Xtal stage is temperature controlled and permits QSY to any of the following frequencies within one minute: 3520, 3533, 3540, 3600, 3716. QSY to the 7000 KC band and use of second harmonics of any one of the first four xtals can be made in two minutes. A 1100 volt transformer with a 5Z3 tube, output well filtered, supplies power to low and medium power stages. A 3000 volt transformer, Rectobulbs, 13 mfd. condenser and a 50 henry choke supplies the high voltage. W7AAT's receiver uses 32-01A-32-01A. Normal station operating frequencies are 3546 and 7092.

Orville is 24 years old, a musician by occupation and married to W7COX who also has her station but who can make use of any of W7AAT's crystals. During the Winter Army Patrol flights across the northern United States, Viers handled press messages up to 350 words every night and received Army commendation for his excellent work. He is now ORS, OBS, OFS, SCM, member of the Rag Chewers Club, Official Trunk Line Station. He has recently been honored with appointment in I-Tappa-Kee as Chief of the Continental Division of ITK and holds the Degree of Sparks. His station will be an important link in the new ITK Network, and will broadcast official ITK Dispatches. In conclusion, Orvy's main purpose in life is to produce a healthy signal of modern trend, engage in traffic handling, rag chewing and at all times be of service to brother amateurs everywhere in every way possible.

●●●

Chief of Communications

RADIO W6FAC, Frank Wagner of Vallejo, Calif., has been officially appointed Acting Chief of Communications and in that capacity will organize, supervise and appoint ITK trunk line stations and command the operation of the ITK world-wide communication network. He will also have charge of contests, and put into operation new plans for ITK communication facilities.

●●●

All Foreign Amateurs, Attention!

THIS fraternity will receive applications from eligible amateurs in any country and will sup-

(Continued on page 31)

E. R. HYSKELL -- SANTA MARIA, CALIF.

A REAL old-timer is W6FNK, Santa Maria, Calif., ITK Brother Nr. 48, who bears the name of E. R. Hyskell. He first took to the air back in the spring of 1909 with a perfectly good automobile spark coil. All band operation simultaneously. By 1911 this pioneer station had increased to pretentious proportions with nothing less than a 2 KW spark outfit with a rotary, by heck!

Being insulted by the government's desire to license the wild and wooly amateur operators, the station was dismantled in 1914. The war found Hyskel pounding brass in the 316th F.S.B., also working telegraph and fone. April 1932 found him lured back into the ham fold by reason of building ham equipment. His earlier activities took place in Portland, Oregon, followed by a migration to Santa Maria in 1926, where the present station W6FNK emanates its signals. Looking behind the scenes we find that this modern station consists of a crystal-control transmitter comprising a 47 xtal osc.—46 doubler-push-pull 211E tubes in final. 180 watts input at 1300 volts. Receiver is 58 TRF, 58 Det. 27 audio. Operating frequencies are: 1766, 1880, 3600, 3636, and 7190 KCs. A recent change provides a 203A in the final which can be grid-modulated by a 24A and a 45, so FNK can swap around between 160 meter fone and CW on 80 and 40 meters.

Hyskell is 41, married, member of the "Wiggling Rocks"; holds ITK "Knight of the Key" Degree, interested in long-winded DX QSO's, and winding power transformers and chokes. Occupation is Asst. Substation Inspector and in his spare time he operates the Hyskell Radio Service.

Practical Grid Modulation

(Continued from page 11)

tube, more grid current is needed for any efficiency within amateur requirements. At least 5 M.A. grid current was necessary .to obtain any output, and apparently about 15 M.A. was necessary for proposed phone operation. The output increases with that particular tube and circuit, up to values of about 40 M.A. grid current. High values of plate voltage were not available in these preliminary tests, so these tests will be continued. High plate voltage is desirable with grid modulation, since the plate voltage is constant and the plate current varies.

With plate modulation, the plate voltage at 100% is doubled. With grid modulation, the voltage is not increased across an audio impedance, so the normal DC voltage can be increased at least 50%, and with some tubes as much as 100% over the recommended values used for plate modulation on class C RF amplifiers. The plate current is lower for grid modulation, thus the tube power input is lower, therefore the higher plate voltage is permissible. The final result is that nearly as much output is obtained with this form of grid modulation as with plate modulation, if the plate voltage supply can be increased. The modulator power output is only about 1/50th as great with grid modulation. The savings should be apparent.

Careful adjustment of the RF excitation will enable one to get good quality at fair values of output even when drawing grid current, providing the modulator is designed properly to work into a low impedance circuit, just as does a driver stage in a class B audio amplifier. Tests were made at W6BUY with modulation transformers having output impedances ranging from 175 up to 12,500 ohms when working out of a 2000 ohm modulator tube, such as a 71A. The best results were obtained when the step-up ratio was adjusted to about 3500 ohm load, i.e., an impedance step-up of 1 to 1¾. The RF tubes were drawing grid current, so this modulation transformer is not unlike an input transformer to a class B audio amplifier, except that a slight step-up ratio could be used. At W6AJF a 1 to 1 or 1:1½ step-down ratio was used successfully. More modulator power is necessary when a step-down ratio is used—but greater grid current can be used with some types of RF tubes, with corresponding higher plate input and carrier power.

For the particular bias used of 150 volts, the instantaneous grid peak voltage might be as high as 200 volts, because grid current is flowing. If the maximum grid current was 15 M.A. with a normal non-modulated value of from 1 to 3 M.A.—the peak instantaneous power = 200 x .015 = 3 watts from the combined input sources. The modulator would then have to be able to supply about ⅓ of this, or one watt. The minimum grid impedance

$$\text{pedance} = \frac{\text{Max. Eg.}}{\text{Max. Ig.}} = \frac{50}{.015} = 3330 \text{ ohms,}$$

which checks pretty well with experimental value of 3500 ohms found by cut-and-try of modulation transformer matching.

One evening while testing with VK7NC on 20 meters, the CW signals were reported QSA4, R5, and changing over to phone the report was QSA4, R4, for voice, which was highly gratifying. J2CE gave W6BUY QSA5, R7 on CW, and QSA5, R8 on phone. J2CF gave CW QSA5, R6 and R5 on phone.

VK2PX gave QSA4, R4 on both CW and phone. These results are given to show that this form of grid modulation puts out a good phone signal, since the above results were obtained on CW for maximum output adjustment.

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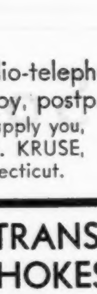

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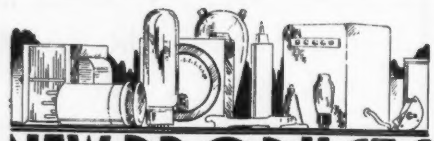

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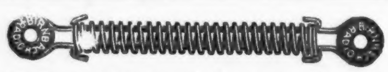
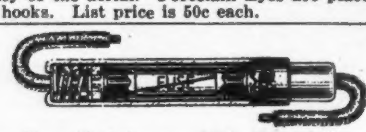


#765 Aerial Spring Adjuster

Birnbach Radio Co., Inc., has developed a new Spring Aerial Adjuster, No. 765, which has unusual features and sells at a very reasonable price.

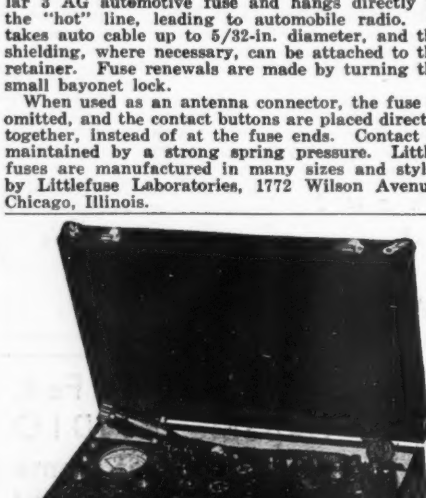
Most antennas will sway with the wind. This causes them eventually to break due to the strain put on them by the swaying. The possibility of coming in contact with high voltage lines is also present by allowing this shifting of the aerial. With the coming of the doublet short wave antenna system, it is evident that some means must be had to compensate the additional weight and strain placed on the antenna proper so as to keep it straight and clear from all surrounding objects. All this can be corrected by the insertion of one or more aerial spring adjusters in the antenna, and thereby making a substantial addition in the efficiency of the aerial. Porcelain Eyes are placed in the hooks. List price is 50c each.



New Fuse Retainer and Antenna Coupler

Littlefuse No. 1070 fuse retainer takes the regular 3 AG automotive fuse and hangs directly in the "hot" line, leading to automobile radio. It takes auto cable up to 5/32-in. diameter, and the shielding, where necessary, can be attached to the retainer. Fuse renewals are made by turning the small bayonet lock.

When used as an antenna connector, the fuse is omitted, and the contact buttons are placed directly together, instead of at the fuse ends. Contact is maintained by a strong spring pressure. Littlefuses are manufactured in many sizes and styles by Littlefuse Laboratories, 1772 Wilson Avenue, Chicago, Illinois.



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Another Effective Antenna System

By FRANK C. JONES

(Continued from page 13)

to cause the final amplifier tube to draw normal plate current. The nodal point is the center of the plate coil, if a push-pull amplifier or toward the high voltage taps if single-ended amplifier with grid to opposite end of plate coil neutralization is used. Don't extend the coupling coil much past the center or nodal point of the plate coil, or undesirable capacity coupling will take place with less power into the antenna and more plate current.

The feeder current for a twisted pair with a characteristic impedance of 100 ohms, properly terminated at both ends, would be one ampere if the final amplifier output was 100 watts. The RF voltage across this line would be only 100 volts, which is from 30 to 100 times as small as across the tank circuit. This accounts for the actual small dielectric loss even in a long line of this type. With 800 watts output, which is about the maximum possible with the amateur regulation of one kilowatt maximum input to a final stage, the feeder current would be 2.82 amperes with a voltage of 282 volts.

The RF feeder radiation varies as the square of the spacing, so with a twisted pair of this type the radiation would only be $\left(\frac{3/16}{6}\right) 2 = \frac{1}{1000}$ as much as for a 6-inch spaced feeder. The result is that the lead-in can be run through trees, around walls and through a small hole in a wall without wasting appreciable signal, either in transmitting or receiving.

The coupling to a receiver should be entirely magnetic since any capacitive coupling would cause the whole feeder and antenna to act as a T antenna system to ground through the receiver. This would greatly increase the noise to signal ratio, so a Faraday shield should be used. A unit of this type, suitable for any of the amateur bands, can be made by using two five turn coils with variable coupling. The one connected to the receiver should be shielded and the twisted pair to it should also be shielded as well as the whole short-wave receiver. A Faraday shield is made by soldering a ground wire along one edge of a row of parallel copper wires with the other ends insulated. An easy way to make a system of this arrangement is to cut across an old space wound coil which is cemented to thin celluloid sheet. This can be easily flattened out and a wire soldered across one end of the parallel wires and grounded to the coil shield. This screen should be mounted across the open end of the coil shield with an antenna coupling coil on each side of it. The coil connecting to the antenna feeders does not need to be shielded but should be arranged for variable inductive coupling to the shielded coil.

A half wave doublet antenna is never a full half wave in actual length because of end effects. It is usually about 5% less. The following table gives the lengths between the insulators at the two ends of the doublet antenna for all the most popular amateur bands. Enough values have been listed to enable an amateur to cut the antenna to correct length if his crystal oscillator frequency is known. In case a twisted pair feeder is used, simply cut out about a foot from the center for the small Y connection and use a couple of small glass or porcelain insulators to take up the strain at the center of the antenna. It is a good plan to use at least 15 to 20 inches of

(Continued on page 30)

Another Effective Antenna System

(Continued from page 29)

good glass insulators at the two ends of a doublet antenna.

Freq. in KC	Ant. Length in Feet
1715	273
1800	260
1900	247
2000	234
3500	134
3600	130
3700	126
3800	123
3900	120
4000	117
7000	67
7100	66
7200	65
7300	64
14000	33½
14200	33
14400	32½

Farnsworth Television Transmitters To Be Made By Heintz & Kaufman

TELEVISION Laboratories, Ltd., of San Francisco and Philadelphia, have licensed Heintz & Kaufman, radio manufacturers at San Francisco, to construct television transmitting equipment under the Farnsworth patents for television by aid of cathode-ray tubes. License for the manufacture of receiving equipment has already been granted to an eastern radio manufacturer in whose laboratories Farnsworth spent two years in perfecting his receiver for commercial use.

Heintz & Kaufman are the manufacturers of all the code-communication equipment used by Globe Wireless, Ltd., a subsidiary of the Dollar Steamship Company. They also have recently been licensed to use the radio patents held by the Westinghouse Electric & Mfg. Co. They have specialized on short-wave radio for many years and are recognized leaders in their field.

Television Laboratories, Ltd., is planning a vigorous campaign for television service to all important centers of population in the United States before the end of 1934. Philo T. Farnsworth has assigned to them nearly a hundred patents which cover every detail in the successful reproduction of motion pictures in radio, including direct pick-up at the scene of action. These pictures are now being transmitted over wide channels in the neighborhood of 5 meters. The received images are reproduced as a brilliant black-and-white motion picture and contain 90,000 elements (300-line) repeated at the rate of 24 pictures per second. The pictures and accompanying sound effects are transmitted on the same wavelength and reproduced from the same cabinet.

●●●

Contest Winners

Jayenay announces the winners of his Ham-Hint contest, mention of which was made in November "RADIO". Wm. H. McAulay, 300 Hillcrest Road, San Carlos, Calif., gets a year's subscription for the best letter on plate voltage efficiency. Jas. R. Donovan, W4WZ, Box 83, Savannah, Georgia, wins a one-year subscription for the best letter on the excitation question.

●●●

Do Doublets Pay?

R. H. Sweeny, W2FEQ, says that he built a doublet antenna using the couplers described by Louis Huber in December "RADIO", but made a few changes of his own which, he says, make his ACSW3 sound like a wizzzz. Here are the suggestions, as submitted by W2FEQ: (1) Use shielded 2-wire cables for lead-in; ground the antenna transformer shield to the cable shield, and also ground the cable shield at the receiving set end. (2) The couplers were wound on Lynch ½-in. insulators. (3) Wind the secondary coils of the couplers on TOP of each primary. The enthusiasm displayed in W2FEQ's letter sounds like FB dope. Others who have built the Huber antenna are invited to write and tell us what success they are having.—Editor.

ITK News

(Continued from page 26)

ply information as to membership requirements. A number of internationally prominent amateurs are now pledged to the Membership Committee. While the ITK International Traffic Net now provides service to all foreign countries, it is hoped that amateurs on the foreign end of these trans-oceanic trunk lines will all be ITK brothers, as is the case of all amateurs on this network within the borders of North America.

There's a prominent amateur, an ITK member, who has been forced to give up his radio career because of ill health. No longer is he able to secure the proper medical attention. His finances are depleted. He has never asked for help. He isn't that kind of a lad. Only recently was it brought to our attention that he can start anew on the road of life if financial help is secured. Perhaps there are some ITK members who are more fortunate than brother "X" . . . who will come to his aid at this critical time. The Hi-Kilowatt welcomes your cooperation.

Last Minute Flashes!

RADIO W3VJ, L. Dean Powell of Salisbury, Md., prominent eastern amateur, is appointed Acting Chief of the Capitol Division. If his spare time permits, he will be appointed for the regular period of time.

Attention, Brothers! Welcome these new members who have just received the approval of the Membership Committee within the few days before this goes to press: W6AKC, W6DWE, W6AWY, W6BRV, W8DED, W2AUS, W6ASV, VE5BC, W6AOA, W6EJU, VE5DD, W7HX, W7GL, W6FBW, W7APR, W6WB, W4AXN, W6GWK, W6WA, W4AFM, W5ATF, and W6BPC.

Policy: In response to many inquiries, we wish to make this statement: **ITK does not at present have any political policy.** When, and if, a political policy is adopted, it shall be an expression of the majority of its members. However, let it be known that at all times **I Tappa Kee** shall courageously and fearlessly champion the rights of the radio amateur. There is no place in this fraternity for the man who cannot think for himself and who does not have the courage of his convictions!

W4AFM-WLRH is Radio Aide for Operations 4CA AARS and built first BC station in West Virginia WAAO . . . W3VJ is Ensign USNR . . . VE5DD will handle traffic bound for the Orient over ITK trunk lines . . . W6ETJ is a key man in our international net . . . W7HX has pounded brass for 20 years . . . W6FBW is Vice.-Pres. of the Santa Clara County Amateur Assn. . . . W6BPC now using 500 watts . . . W6EJU is an exponent of the Royal Order of the Flurf. Hi . . . W6RJ is SCM . . . W6ZF now using new 1KW xmtr . . . 6DWE visited W6CVL . . . W6EDW provides outlet to most Pacific countries for traffic . . . W6BIJ built new rig, bleeders shorted and fireworks followed . . . W6AKW sez farming doesn't lead to prosperity . . . W9DBW plays with hi-quality speech amplifiers and expensive oscillographs at the U. of Iowa as Speech Engineer . . . 9JC has a new FBXA and new xtal xmtr with pair of fifties in final . . . W6BMC moving heaps of traffic, over 600 monthly . . . VE5BC has held stock in the Canadian Marconi Co. since 1906. That's believing in radio . . . W7DXD is President of Iota Tau Kappa (Commercial Div. of ITK) . . . W7AVL received his first copies of "RADIO" from the late Major Mott. Remember him from the old Catalina Island radio days? . . . W8OQ busy as Great Lakes Div. Chief and looking for capable men for State Chief appointments . . . W6BOQ reports very nice raise in salary at KFI-KECA due to NRA . . . This also affects W6DOB at same stations. Congrats . . . NRA seems to be a station well worth a QSO, eh, wot?

ITK Station Activities

W6BCX is grinding xtals as fast as the skin grows back on his fingers and is accumulating a goodly array of fone equipment for a new rig.

W6AWY is saving his sx to buy filter condensers for a 3300 volt plate transformer. AWY was heard on the air for the CQ ITK contest, battin' out some mean CQ's.

W6AKC is building a fine big shack for hamming, photography and Naval Reserve activities. Allen holds the Degree of Lightning Jerker in ITK and is an USNR Ensign, commanding Unit Two.

W5ATF, Buck McKinney of Dallas, whose station description was in the Globe Girdler section of Dec. "RADIO", comes into ITK well recommended by Lyle White, Chief of the Border Division. Welcome, Buck!

W7AAT, Chief of the Continental Div., reports a score of 17,640 points in the Sweepstakes contest! Longest continuous session at the key was 28 consecutive hours. Good work, Orvy!

"The Gainer"

(Continued from page 8)

Instead of being counted in numbers of turns, the cathode winding is more apt to be in the neighborhood of a half turn.

Our system not only allows more turns on the cathode coil but also permits considerable latitude in the control of regeneration by moving this winding closer to, or farther away from the grid coil. In order to get good signal strength it is necessary for the screen voltage to be of a fairly high value. If the cathode coil is too close to the grid coil the tube will go into oscillation at a value of screen voltage below that necessary for maximum signal strength. Obviously, if spaced too far from the grid coil, oscillation will be impossible. Approximation of spacing alone is possible, but in our laboratory receiver the coils were spaced $\frac{3}{16}$-inch apart. The number of turns on the cathode-ground coil not only has an effect on the screen voltage necessary for proper regeneration, but in addition dictate whether or not the set will go into oscillation quietly or with a plop.

The shielding of this receiver leaves little to be desired. The signal-to-noise ratio is so much improved that we wonder why all receivers are not completely shielded.

The construction is greatly simplified and beautified by the use of the laboratory shield cans made by R. H. Lynch and other manufacturers.

INCREASING POWER OUTPUT

(Continued from page 7)

is self-explanatory. The efficiency continues to increase above 5000 volts, but this may be considered an advantageous maximum for the Type '52 because positive ion bombardment of the thoriated filament increases rapidly above 5000 volts. This bombardment can shorten the life of a tube quite seriously by literally knocking off the precious thorium so necessary for correct emission. Of course, high plate currents will also shorten the filament life, so a good medium may be drawn between 4000 and 5000 volts. The bombardment is due to the small amounts of gas left in a tube after evacuation, which means that only "hard" '52's are recommended for these high voltages.

From time to time small improvements on the layout as given in the original article have been devised. These have all been incorporated in a transmitter designed and built for W6BDD, which, for several reasons, merits a complete description. Not only was everything about this set designed on paper beforehand, but we were given a free hand as to choice of necessary apparatus, so that a really coordinated assembly was the result. While the layout as a whole may not appeal to many, it lends itself admirably to instructive description.

Operation

THE set is rated at approximately 900 watts measured output on 3.5, 7, and 14 MC or very close to 90% efficiency. The complete circuit diagram of the RF part is given in Fig. 1 along with all constants. A Type '47 crystal oscillator is employed on 3.5 MC with 300 volts; the next two tubes are Type '10 doublers running at 750 volts which excite the Type '10 buffer on either 7 MC or 14 MC. The three double throw knife switches can cut one or both doublers out of the circuit as desired—both doublers are used on 14 MC, the second is cut out for 7 MC, and both are left out when on 3.5 MC. It will be noticed that the two outer switches are double pole, the extra contact being used to automatically apply voltage to the doubler as it is cut into the circuit. The Type '10 buffer in turn feeds the Type '52 buffer operating at 4500 volts and 400 watts input. The output amplifier is a pair of push-pull Type '52's at the same voltage and 1000 watt input. The whole layout is contained on a stout oak table measuring 2 feet by 4 feet and standing 4½ feet high. Referring to the photograph of the whole set, the crystal oscillator and the two, 750 and 4500 volt plate supplies are on the bottom shelf. The middle shelf contains the three Type '10 tubes and the buffer '52, while the table top proper is comfortably occupied by the output amplifier. This particular lay-out of apparatus is finding favor in many quarters due to its accessibility, convenience, and ease of construction. It is beautifully simple and with judicious placement of parts all shielding is obviated.

The crystal oscillator is quite orthodox, although it employs an abnormally high grid leak to increase tube stability—high power output was not desired because the crystal should not be "the whole source of RF power, but only a frequency control". It is mounted in a 6-in. by 8-in. by 12-in. electralloy can to insure isolation from outside effects. The excitation tap is taken off in the middle of the plate coil, a position which gives maximum oscillator stability even if not greatest output. The tube never draws more than 15 ma.

The Type '10 stages provide a flexible unit by which adequate excitation can be supplied the buffer '52 on all three bands. They are laid out with the tank coils all at right angles in order to prevent feed back, but otherwise no uncommon care was taken in the placement of the remaining components. Complete coil data is given in the table of specifications. Resistance bias is used throughout, the values not being critical. Care should be taken with the RF chokes—the ones described here have proven absolutely effective on all frequencies even in comparison to the Navy type chokes. They are 150 turns of No. 32 on ¾-in. tubing, 50 turns spaced the wire diameter, 50 turns close wound, and 50 spaced.

The fact that much more trouble was encountered in the Type '10 stages during the first tuning-up than in all the rest of the set put together prompts a few words on doubler and low power buffer ills! The first doubler worked well enough to excite the Type '10 buffer when on 7 MC, but the second doubler refused to mote—all this on 550 volts. Many things were changed, but the only remedy was either to run up the oscillator output or to increase plate voltage—the latter proving the best. In the end nothing else was different—the voltage had simply been raised to 750. The conclusion being that a 14 MC doubler, also 7 MC doublers, must have sufficient excitation. This contention is borne out at W6CUH, where a 14 MC Type '10 doubler, preceded by a 7 MC Type '10 buffer, adequately excites the buffer '52 to 400 watts input on 14 MC—the Type '10's having 600 volts on the plates. A Type '10 buffer will work on a seemingly impossible amount of excitation, but try to make it double!

The buffer '52 and its associated equipment are mounted at the right end of the second shelf. The plate tuning condenser is a National 6000 volt .0001 mfd. with split stator. A considerable improvement was made in the stability of this stage by leaving the rotor of this condenser floating — neutralization is much more complete. The tank coil is mounted on G.R. stand-off insulators by means of ordinary gas line unions. It may be noted that the bias on this stage is semi-automatic. The bias lead is connected to the center of the output amplifier's grid leak, thus it is the grid current of the final stage that provides most of the bias for the buffer, and the output of the buffer therefore controls its own bias. This is an advantage at the higher plate voltages as it helps hold down the buffer plate current when coupling is tightened.

The output amplifier occupies the whole top of the table and is a thing of simplicity and symmetry. The grid circuit is at the right where it is handy to the buffer '52 just below it. Going from right to left, we have first the two excitation feeder condensers, then comes the grid tank coil followed by the grid tank condenser, next are the two Type '52's with the neutralizating condensers mounted between them, and on the left are the output tank condenser and coil. Everything has been well spaced and wired with quarter inch copper tubing.

The grid tank and coupling system have been a source of trouble in many cases, so it is well to point out some precautions and explain an improvement that resulted in more stable operation of this circuit. In the older version with the feed condensers connected directly to the ends of the grid tank trouble would arise because we would often be tuning the pick-up coil instead of the grid tank. If everything is correct there will be very little RF on the pick-up coil as compared to the ends of the grid tank. Nearly all chance of the occurrence of this condition has been reduced by clipping the feeders in on the grid tank as shown in the diagram, the difference from common practice being that the feeder condensers are retained. This is done because on 7 and 14 MC the capacity introduced by the feed line is all that is used to tune the grid tank, and clips alone provide far too

Increasing Power Output

rough an adjustment of tuning. Another improvement resulting from clipping in is a lowering of the RF voltage across the feed condensers.

The pick-up coil is coupled to the plate end of the buffer tank, either end being appropriate, and is mounted on the leg of the table, as shown in the photograph. A simple and effective method of varying the coupling lies in stretching or compressing the coil to loosen or tighten the coupling, respectively. The feed line consists of No. 10 lamp cord. It runs up the table leg and across under the table top, each lead passing up through the top directly under the corresponding condenser. The grid tank is mounted similarly to the buffer tank. The use of the small grid chokes L9 directly in the grid lead of each tube was an improvement over the old two ohm resistors.

The Output Circuit

THE output tank circuit is husky to say the least. The condenser is a double section Wireless Shop affair, each section being .0001 mfd and rated at 7500 volts—yes, it still arcs over with very little encouragement! The use of a double section condenser not only allows a higher breakdown voltage but, what is more important, permits the use of higher L because of its much lower minimum capacity. The danger of breakdown may be obviated by resurrecting the ancient practice of clipping the tuning condenser across a small but equal number of turns each side of the center tap—clips are quite permissible, the low tank current being insufficient to even warm steel clips. The tank coil is made of 3/8-in. copper tubing only for the sake of rigidity; it is mounted on seven-inch pyrex stand-off insulators by means of gas line unions. The occurrence of unbalanced conditions in this push-pull stage has been traced to differences in the two halves of the output tank coil—not only must the turns be equal, but the lengths of the two halves must be equal. The best method of adjustment is to pull the mid-tap back and forth until the tubes are balanced.

The antenna is one of the most important parts of a transmitter, so we will take a brief look at the single wire fed Hertz in our relentless search for efficiency. This type of antenna feed, applied to a half-wave 7 MC radiator, works very well on the three commonly used amateur bands and does not unbalance the push-pull stage when the feeder is working properly. In order to make sure of correct antenna and feeder operation, Windom's original measurements were duplicated and the resulting flat top length and feeder distance off center agreed within a few inches with the dimensions obtained from his formulas. From this agreement it is apparent that the formulas for the single wire fed Hertz can be safely relied upon under varying conditions. One fact brought out in these feeder experiments was the importance of having the feeder perpendicular to the radiator for at least one quarter wavelength—the current at the center of the flat top rose 10% when the feeder angle was changed from 65 to 90 degrees with no change in the output amplifier input.

To return to the transmitter proper, the plate supplies are entirely orthodox as to circuit design, but unusual care has been taken with insulation and the like. All high voltage wiring was done with good grade high tension cable. The power transformers are also insulated very carefully. Small RF chokes were placed in all the secondary leads of the high voltage transformers to preclude transformer breakdown from stray RF. The 750 volt plate supply employs two Type '66's and a choke input brute force filter. The high power supply consists of a 2 KW 9000 volt c.t. transformer feeding a pair of Type 565 15,000 volt inverse peak mercury vapor rectifiers. A 1 mfd 10,000 volt condenser and a 2 henry 1000 ma. choke form the resonant filter which is sufficient to produce a pure DC note. A 0-500 ma milliammeter serves to read the plate current of either of the high power stages while a 0-300 meter is used on the low power stages. These meters may be introduced in the plate lead of any desired stage by means of small jack type d.p.d.t. push button switches—the use of these switches is a real convenience because currents can be checked at the push of a button. An important point in favor of their use is that they eliminate the chance of shock even though placed in the positive leads. More later about operator safety.

Keying

PRIMARY keying is employed on the two Type '52 stages—the Type '10 stages running continuously during operation. Actual keying is accomplished directly in the primary by a straight key with 1/4-in. silver contacts—the current being about 18 amps at normal load. A relay fitted with 3/8-in. silver or dime contacts will serve equally well, but it must be correctly adjusted if sticking is to be eliminated. Correct adjustment involves using a very strong tension on the armature—the power of the magnets should be increased if necessary. Contact spacing of about 1/32-in. is best and allows the relay to follow well.

The question of safety to the operator has been carefully considered in this set, for there are entirely too many "Silent Keys" due to lack of care in the installation of high voltage plate supplies. Haywire layouts have absolutely no place at high voltages, especially at 4500 volts—all testing and tuning should be done at low plate voltages. In this particular transmitter there are several points that make for a longer life span on the part of the operator. The primary keying itself affords a large factor of safety because the plate voltage is only on when the key is down, and a normal operator usually is quite careful and watchful when holding down his key with the intention of tuning the set—it is impossible to forget and leave the plate voltage on when a circuit change is about to be made. The use of dials without projecting set screews eliminates another source of danger. The mounting of the neutralizing lamp and loop on the end of a short wooden stick has lowered the chance of shock from accidental contact with the tank coils when neutralizing or testing. And as final insurance all wiring is solid and thoroughly insulated.

General

THE performance and flexibility of this set left little to be desired. An output of 900 watts on 3.5, 7 and 14 MC speaks for itself—band changes never require more than three minutes. The output quality represents almost the ideal in amateur signals. Reports have also been gratifying; during its short time on the air this rig has been R9 in New Zealand on both 3.5 MC and 7 MC. None of the components have shown any signs of overload; the whole thing performs as smoothly as a fine watch and has not bothered a BCL yet. The efficiency is about 90% in the output amplifier, while the over-all efficiency of the entire transmitter is actually more than 50%—a value often hardly approached in certain output amplifiers alone.

We have endeavored to furnish convincing proof by means of the efficiency curves that high amplifier efficiency and consequent greater output are the direct results of the use of Low-C in the output tank, high voltage on the plates of the final amplifier tubes, and high but correct excitation.

In conclusion, it is hoped that this article has aided in explaining RF amplifier operation and has at the same time furthered the cause of crystal control and the Type '52.

"Blind Traffic"

(Continued from page 4)

stopped and made a few remarks—like wondering whether I was hearing him. Then he said to stand by while he listened to find out if by chance I was at home, or might have brought a portable transmitter with me. When he came back he shot me ten messages in a string. Due to my excitement, the critical state of my portable receiver, and my hands being so numb, I had many fills to ask for on our next schedule from home. Finally he stopped, saying that at our next blind sked—Thursday—he would be on with another batch. He signed off just as the cook rang the cow-bell for breakfast at six. Said cow-bell, by the way, was donated by my crew. We had come upon the skeleton of a cow that had been polished off by wild animals. The bell that Bossie had been sporting in her palmy days was found among her ribs.

"On the following Thursday I did much better. I had lengthened the antenna and changed its direction. Also I had souped-up the receiver by adding a second audio stage—although I had only one 45 volt B battery. From then on Leon's traffic was copied solid, a batch at a time—sometimes as many as 20 in a string. He sent 'em single and at a good speed with that clear fist of his. And then I would chuck the pencil and paper, while the fones and I would crawl down deep into the sleeping bag and enjoy, hugely, Leon's one-way conversation.

"It was during one of these one-man ragchews that Leon announced the arrival of a new Collins 32A transmitter. He wanted to try it out. He told me to listen on the frequency of KA1NA because he had borrowed 1NA's crystal. I hadn't much hope of hearing him because his power stage consisted only of a pair of 46's in parallel. But, lo and behold, there was that crystal note calling W6CXK! I was able to copy all he said with it. For the next sked he had the Collins driving a 203A. That brought his signal strength away up. There has been much interference, but I have learned to concentrate on Leon's signals and ignore the guys with more power than brains, who persist in tuning their sets during the transpacific traffic period. The messages which were received during the blind skeds were sent down the mountains to my sister, who typed and mailed them. Only a day lost in the transfer.

"At the end of the second month came the big storm that chased me down home. How the wind did howl through the timber! And when the rain started at 7:00 P. M. it came in whipping sheets. Before this we got us a tent with a stove in it. It leaked in a dozen places. Soon a veritable river was coming down through the meadow and past our doorway. It looked as if we should have to take to the lifeboats before morning. With the tent lashing and popping I was loath to go to bed. A deluge would hit the tent on one side, then a backlash of the wind would slam one against the other side. We let the fire go out for fear the tent would collapse on us and take fire. To keep from freezing we had had the stove red-hot; but the stove-pipe was swaying with the tent and water pouring on the stove and filling the tent with steam. Trees were coming down at intervals. That's a terrifying sound—especially when you can't see them and don't know where they will strike. First the sharp crack as the tree starts its death fall, then, as its bulk reaches the other trees and undergrowth, that unforgettable crash coming through the turmoil of the storm! It

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"Blind Traffic"

(Continued from page 34)

echoes and re-echoes among the mountains. The earth shivers from the impact, and shivers of your own race up and down your spine.

"At last, being worn out by being so scared, I says to myself, 'Aw, what the hell!' and crawled into bed with my clothes on. I fell asleep with water from a leak pouring on the tarpaulin I had spread over my bed. At four A. M. I was awakened by the terrific crash of a tree falling nearby. I concluded that I didn't really need any sleep, anyway. The tent having stood the strain this long, I built a fire and tried to find a spot in which I could dodge the water long enough to get warm. Meanwhile the rain had turned to snow and the tent was getting heavier. From 4 o'clock until daylight sure was a long stretch. At sked time I had a picture of Leon passing a shirt-sleeve over his heated brow and grinding out traffic from troubled people in PI and China for a feller up in the Sierras of the USA who was having so many troubles of his own that he wasn't even trying to listen.

"After about a hundred years, daylight came. Deep snow over everything. The upper part of the meadow was a lake from which a river ran down each side of the tent. We waded down to the cook-tent. Down there everything was wet and blown to hell. The cook was cursing the Forestry Service, the weather man and everybody else he could think of at the moment.

"We managed to make some coffee. With that inside me, I decided to strike for home before I should be snowed in for the winter. I'm not keen for sticking around, worrying about how the family is getting along down home, nor living on grub dropped from an airplane. The snow had drifted over my old heap and into every crevice of her. I shoveled her out and then tried to dry out the ignition with a gasoline torch. Once the storm eased up a little and one of the gang took some snapshots. I worked at the car for three hours and then gave it up. I got every man available to shovel and shove. We got her out onto the road that begins with a steep downgrade four miles long. After coasting and cursing for a mile, one cylinder commenced to shoot. That warmed up the next one and finally all six were firing. Then I sat a while and speculated on something I hadn't thought of before—how I'd make the last ten miles myself if the engine failed to start in the first four. I covered her with a piece of old canvas, then went back to camp and got my stuff. About all the outer clothes I had were on me, and soaking wet. My woolen pajamas and two extra shirts were wet, but I put them on, anyway. With an old army overcoat—also wet—I felt twice as heavy as when I came up.

"Back at the car I started down the mountain in the blinding storm. Behind the windshield I couldn't see a thing; the snow was so thick the wiper wouldn't push it off. And hanging out of the car the snow stung my eyes like hail. I could see only my side of the road. I just hugged the cliffs on my side and hoped I wasn't too close to the precipices on the other.

"When at last I reached home I found the storm had put our power line out. When this was fixed up it was found that a transformer was shot also. When the power company installed another I had only 88 volts instead of 120. So I rigged up an autotransformer and, with rotten regulation, I

(Continued on page 36)

"Blind Traffic"

(Continued from page 35)

managed to raise Leon when he called on next sked.

"Thus ended the episode of blind skeds. And hats off to Leon C. Grove, KA1LG, whose perfect signals and perfect operating made them a success.

Signed, "EMILE GUIDICI, W6CXK."

Two sterling specimens of the genus homo, I'll say! Carrying on the traditions of the true amateur. Doing a fine, unselfish public service for a fine lot of men and women who need it. Giving freely of their own time, their own specialized knowledge and their own money; and with no thought of return other than the pleasure they get out of the work. Each obviously sincere in his belief that the other deserved most of the credit. And each with a wholesome admiration for the other. Well, I know them both, and they are both right.

The foregoing account merely emphasizes the great value to our nation of the amateur trans-pacific message traffic for our people in the Orient and their families in the United States. It must be remembered that these two amateurs, Guidici and Grove, are by no means the only trans-pacific traffic handlers. There are many others who have long records of achievement extending back to the first days when the short waves bridged the Pacific—back to a time long before the commercial corporations took their first faltering footsteps on the path across the world's biggest ocean.

Now these same commercials think they have found a way to stop this especial kind of amateur service. They made use of the mechanism of a commercial treaty by incorporating in the Madrid convention this provision:

"It shall be absolutely forbidden to licensees of amateur stations to transmit internationally messages emanating from third parties."

The source and nature of messages—either commercial or amateur—was, and was known to be, a wholly improper subject for discussion at an international convention. Every nation has the prime right to regulate its own amateurs in its own way and without interference by other nations. That right is plainly stated as the preamble of all international radiotelegraph conventions.

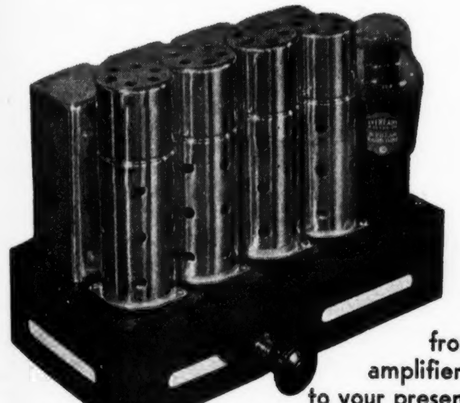
It remains to be seen whether the United States Senate will ratify the above-quoted attempt to stop a free service that is of great value to thousands of the citizens of our country.

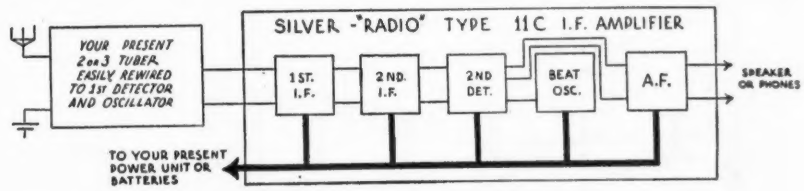
CLAIR FOSTER, W6HM.

NOTICE! Those who wish to advertise in these RADIOADS columns and who do not desire to divulge their names and addresses can use BOX NUMBERS, and all inquiries will be mailed, unopened, to the advertisers.

McMURDO-SILVER

$12.60 Makes an Advanced Super Out of Your Present Two or Three Tuber!





Now $12.60 makes an up-to-the-minute superheterodyne out of your present short-wave receiver! Think of it—all the sensitivity, selectivity and freedom from noise of the most advanced type of superheterodyne is yours for $12.60 without the loss of one cent's worth of parts in your present two or three tuber. Is that the answer to the amateur's dream . . . or is it the answer. For exactly $12.60 you can buy from your dealer or direct from the laboratory the new Silver "RADIO" air-tuned i.f. amplifier kit fully assembled—wired and aligned if you desire—all ready to connect right up to your present set and turn it into a superhet with only a couple of hours work!

The basis of this change is the new Type 11C 465 kc. Two Stage Air-Tuned I.F. Amplifier, audio beat oscillator, second detector and audio stage illustrated above. Developed by RADIO magazine's technical staff and McMURDO SILVER, it is the perfect i.f. amplifier for any superhet.

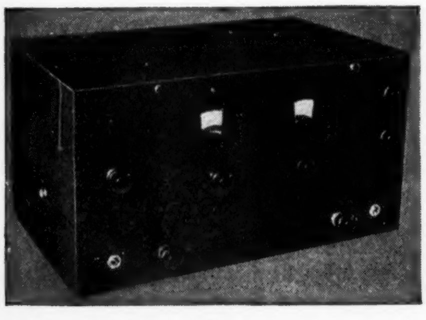
With it you use your present tuned r.f. and detector circuits as detector and oscillator with only a few wiring changes, and presto—you have the latest and best superhet for a cost of only $12.60.

No matter if your set is factory or home built, you can make the change in a jiffy. No matter if it's battery or A.C. operated—just order the 11C amplifier for 2 volt battery or 2.5 volt A.C. tubes and the job is as good as done.

And your wholesale price is only $12.60 assembled but not wired, or $3.60 extra for wiring and exact alignment to 465 kc.

Send in your order at once, get the thrill of operating an advanced, up to date superhet, and watch your DX jump 1000%.

The 11C amplifier comes complete with full instructions for converting existing sets, and full dope on single-signal crystal filter addition so simple it's a "push-over."



5B Single Signal Super

Circuit—Eight-tube superheterodyne.
Tubes—'58 tuned r.f., 2A7 1st detector—E.C. oscillator, two '58 tuned i.f.s., '58 audio beat oscillator, '56 second detector, '59 output, 5Z3 rectifier.
Range—1550 to 30,000 kc.—five amateur bands on one dial.
Tuning—One main illuminated vernier tuning dial, smooth and easy, directly calibrated in megacycles. Band spread tuning **anywhere** in range—amateur, broadcast, commercial. 100 degree band spread 20 and 40 meters—**200 degree** spread 80 and 160 meters.
Wave Length Change—Same, positive, 6-gang wave change switch approved by Admiral Byrd and used in his four MASTERPIECE 11s.
I.F.Amplifier—Dual air tuned, Litz wire . . . 465 kc.
Beat Oscillator—Electron coupled '58. Beat note pitch adjustable from front panel.
Sensitivity—better than one microvolt absolute.
Selectivity—Circuit designed, built and adjusted for crystal resonator, without crystal, band width 21 kc. 10,000 times down. With crystal, absolute single signal (50 **cycles** wide.)
Power Output—3 watts undistorted. Supplied complete with Jensen dynamic speaker, and head phone jack on front panel.
Shielding—100% perfect, all parts individually shielded. Overall cabinet shield easily removable with six thumb nuts.

Send 3c stamp for new complete catalog describing above items, E.C. Frequency Meters, New Airplane Dials, Relay Racks, R. F. Chokes, Audio, Power and Filter Transformers, and a host of new and interesting amateur and commercial apparatus.

PRICE $59.70

net to amateurs with eight guaranteed and tested Raytheon tubes. Each set complete with selectivity control, crystal switch, phasing condenser and crystal socket—ready for insertion of crystal. Add to above price $9 net for Bliley crystal with holder and complete crystal alignment—complete price, ready to go, single signal with crystal, $68.70.

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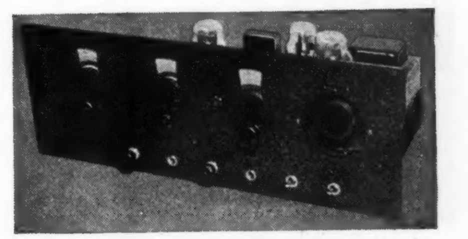
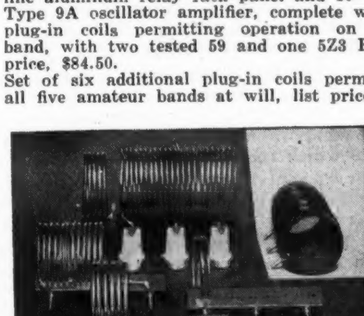


"Tritet" Five Band Oscillator-Amplifier

This unit is essentially the five band "Tritet" five band exciter, developed by James Lamb of QST put into practical and simple commercial form on a 7"x19" black crystalline aluminum relay rack panel and 10" deep steel chassis. Type 9A oscillator amplifier, complete with choice of three plug-in coils permitting operation on any one amateur band, with two tested 59 and one 5Z3 Raytheon tubes, list price, $84.50.

Set of six additional plug-in coils permitting operation in all five amateur bands at will, list price $10.00.



Copper Tube Transmitting Inductances

Type 18 inductances are wound with 1/8" O. D. nickel-plated copper tubing spaced 3/32" between turns to a 2½" diameter and rendered extremely rigid by means of tight fitting linen base bakelite clamps, which also carry three contact plugs.

For antenna coupling a special Johnson standoff insulator is provided carrying on a rotable pin a six-turn antenna coupling coil provided with flexible leads for circuit connections. This 18F antenna coil is suitable for the 1.7, 3.5, 7.0 and 14.0 and 28.0 MC amateur bands with series and parallel antenna tuning.

Type 18 copper tube inductances for any amateur band, $3.00 each, list.

Johnson type 205 glazed porcelain standoff jack socket. Per set of three for 18A, 18B, 18C, 18D or 18E inductance, list price $0.75.

McMURDO-SILVER, INC.

1741 BELMONT AVENUE CHICAGO

CROSLEY *Presents*

VENTILATED FRONT

This important feature of all Crosley 1934 models greatly improves the operating efficiency by drawing in cool air from the front and expelling it from the rear, insuring perfect ventilation of the power unit even when the refrigerator is placed in tight-fitting closet or close to wall. It makes for better performance and less current consumption.

MODEL EA-35

CROSLEY SHELVADOR

(UNITED STATES PATENT RE-ISSUE NO. 19,008)

only $99.50

MODEL EA-35

This Crosley Shelvador Electric Refrigerator (shown open above) has a NET capacity of 3.5 cubic ft., with 7½ square ft. of shelf space. Two ice trays, each with 21-cube capacity, or 42 cubes in all. No-stop defrosting control will defrost while operating. Thoroughly insulated body and door. Porcelain interior. White lacquer exterior with black trimmings. Stamped brass hardware is chromium-plated. *Ventilated Front*... refrigerator may be placed in small closet or close to wall. Illuminated interior. Dimensions: 48″ high, 23⅞″ wide, 24$\frac{1}{16}$″ deep.

THE startling success of the Crosley Shelvador Electric Refrigerator last year will be exceeded during 1934! There is no question about it. For here's Shelvador dressed in *STREAMLINE BEAUTY*, Shelvador with new, added features . . . Shelvador—in short —in a new, finer, more convenient edition.

Quick, ready sales are written all over these new models. Their breath-taking beauty catches the eye of the housewife. Nothing like it has ever been seen. Not just an "improvement" on former models in smartness . . . a wholly new and entirely different concept of what the refrigerator ought to look like.

The Shelvador feature, patented and exclusive, is of course the Big Idea in the 1934 Crosley Line. This—and Crosley's quality and value—is what lifted the Crosley during 1933 way up among the biggest leaders in refrigeration. It meant hundreds of thousands of dollars in profit to Crosley dealers . . . and competitive dealers also have occasion to remember it!

This is the refrigerator of the hour. Its sales message is *packed* with profit. It is *the* golden opportunity for refrigerator dealers . . . and for other dealers who want to enter this field. It is endorsed and approved by the largest, oldest, and most successful refrigerator outlets who pronounce it the outstanding line of the refrigerator world. See your Crosley distributor . . . this proposition means *real* money to you.

AUTOMATIC ILLUMINATED INTERIOR IN ALL MODELS

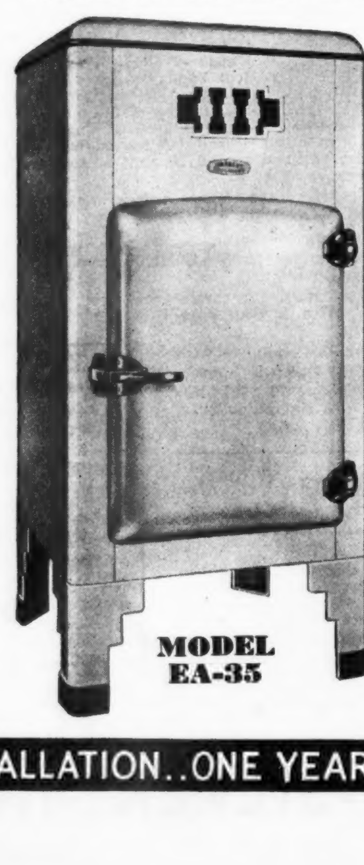
YOU will be surprised at the roominess of even the smallest Crosley 1934 model. Consider, for example, the one illustrated above. While the rated size of this box is 3.5 net cubic feet, the "usable" food storage capacity is increased about 50% by the Shelvador feature. In these days of daily deliveries, this box should be large enough for ordinary family requirements. The price, extraordinarily low, becomes still more amazing to your customer when she learns that the size is comparable to a larger box. Here is a leader of leaders from which to "sell up." All Crosley models, in addition to the special features elsewhere described have: The self-contained removable unit that may be exchanged without interfering with refrigeration and that has an unequaled record for trouble-free service; the ventilated front; thermal cut-out; no-stop defrosting switch that defrosts while operating; one-piece, rounded-corner porcelain interior; flat bar shelves; illuminated interior. All models available in full porcelain at slight extra cost.

Montana, Wyoming, Colorado, New Mexico and west, prices slightly higher.

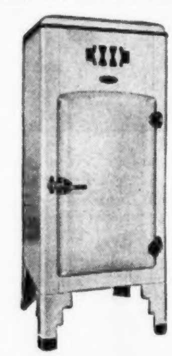
The Crosley Radio Corp., - Cincinnati

(Pioneer Manufacturers of Radio Receiving Sets)

POWEL CROSLEY, Jr., *Pres.* Home of "*the Nation's Station*"—WLW



MODEL EA-35



MODEL EA-43

Designed for apartment or home. NET capacity 4.3 cubic ft., with 9.15 square ft. of shelf space. Shelvador greatly increases "usable" capacity. Two ice trays, each of 21-cube size; total 42 cubes. Also one double depth tray. No-stop defrosting control will defrost while operating. Thoroughly insulated throughout. Stamped brass, chromium plated hardware of modern design. Porcelain interior; exterior in white lacquer with black trimmings. Ventilated front. Illuminated interior. Dimensions: 54$\frac{11}{16}$″ high, 23⅞″ wide, 24$\frac{1}{16}$″ deep. Price — delivered, with one year free service. $117.00

ALL PRICES INCLUDE DELIVERY..INSTALLATION..ONE YEAR FREE SERVICE